T2 versus T2* contrast: Strong differences in MRI of cortical layers in living mice

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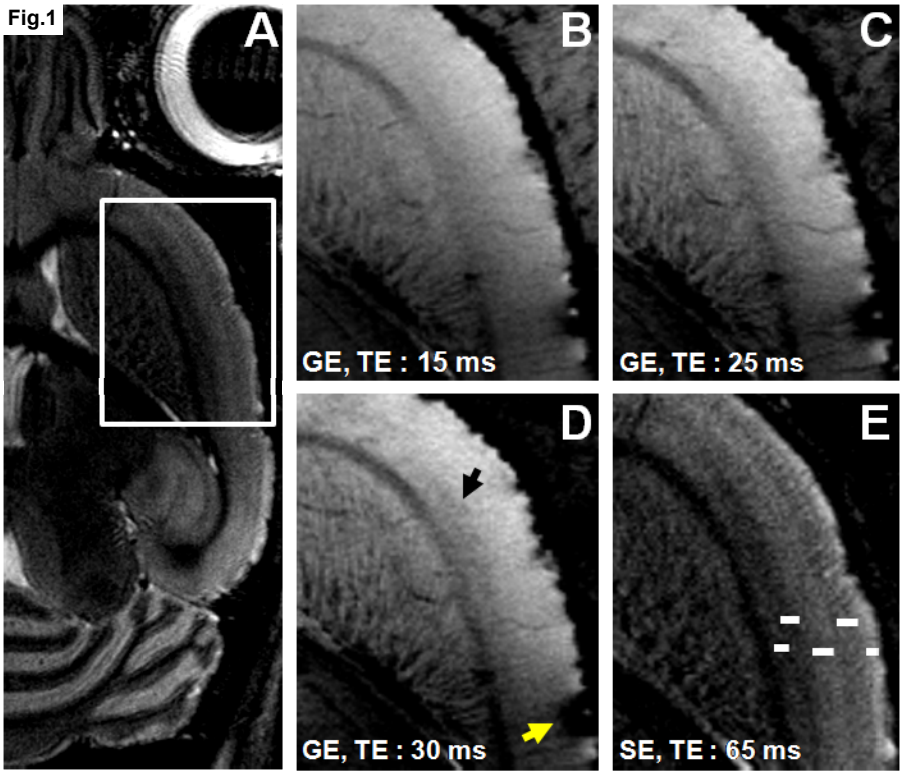
Introduction

Genetically modified mice have been successfully used to investigate the role of genes or related interactions on cortical development. Moreover, human diseases which significantly affect the cerebral cortex (e.g., multiple sclerosis, Alzheimer disease) are commonly studied with mouse models. Both research lines lead to an increasing demand for the *in vivo* detection of cortical fine-structures in healthy and pathological conditions. Complementing histology and *post-mortem* MRI, *in vivo* MRI allows for the visualization of cell structures in the intact, functioning brain without suffering from shrinking or other preparation artifacts. In humans, MRI contrast in cortical grey matter has mainly been related to myelin and iron content [1,2]. Therefore, the aim of this study was to further analyze the *in vivo* MRI contrast behavior of the cerebral cortex in mice.

Fig.1



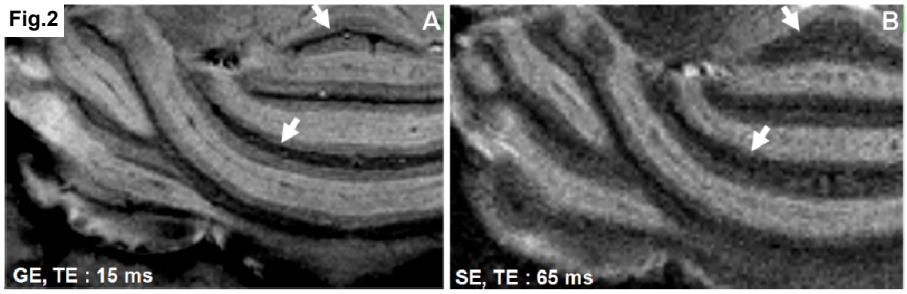
Methods

Adult C57BL/6 mice were anaesthetized by 1-1.5% isoflurane in a mixture of oxygen and ambient air and positive pressure ventilated via an endotracheal tube. T2-weighted (SE) images (multislice FSE, TR/TE=4200/65 ms, 8 differentially phase-encoded echoes, 14 slices, matrix size 512 x 512 [3]) and T2*-weighted (GE) images (multislice FLASH, TR = 500 ms, TE between 6 and 30 ms, flip angle 60°, 14 slices, matrix size 400 x 400) were acquired within a measurement time of about 1 h each with a spatial resolution of 40 x 40 x 300 μm^3 at 9.4 T (Bruker Biopsin, Germany) using a 4 element phased-array surface coil for signal detection.

Results and Discussion

T2-weighted images revealed the typical 5 layer-like structures as described previously [3] (Fig. 1A and E, white bars). On T2*-weighted images, however, even at an echo time of 30 ms, which already leads to strong susceptibility artifacts at the outer border of the cortex (yellow arrow), only one darker layer (black arrow) could be separated from the otherwise homogeneous grey matter signal of the remaining cortex. On the other hand, in the cerebellum, T2*-weighted images better distinguished the myelinated white matter (Fig. 2B, white arrows) from the granular layer (Fig. 2A).

Fig.2



Conclusion

Cortical 5-layer microstructure in mice can best be visualized by *in vivo* MRI with T2 but not T2* contrast. This observation indicates that in contrast to humans iron and myelin content may not be the predominant sources of cortical gray matter contrast in mice.

On the other hand, T2*-weighted MRI may become a valuable tool for *in vivo* studies of the cerebellum of living mice.

References

[1] Walters et al, PNAS 2003; [2] Fukunaga et al, PNAS 2011; [3] Boretius et al, NeuroImage, 2009