MRI of Cell Layers in Mouse Brain in Vivo Using Intra- and Extra-cellular Contrast Agents

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Target Audience: Anyone who is interested in high-resolution MRI of the brain of mammals ranging from genetically modified mice to human.

Purpose: The aim of this study using the brain of living mice was to examine the effect of (i) systemic administration of manganese (Mn) on T1-weighted (T1W) and T2-weighted (T2W) MRI and (ii) intracranial administration of Gd-DTPA on T1W MRI.

Methods: Four mice received a subcutaneous injection of MnCl2 (0.12 mMol/kg). Another four mice received an injection (5.0 μL) of 100 mM Gd-DTPA into a lateral ventricle as well as injections (0.3 μL into each side) of 50 mM Gd-DTPA into the olfactory bulbs. At 9.4 T, data were acquired at 20—210 min or 2—3 days after Gd-DTPA or Mn injection, respectively. T1W 3D FLASH (TR/TE = 22/7.6 ms, α 25°, measuring time 12, 48, 72, or 96 min) and/or T2W 3D FSE (TR/TE = 4200/48 for sagittal and 4200/80 ms for horizontal sections, measuring time 161 min) were performed. T1 was determined using spin-echo MRI with TR/TE = 200—10000/10 ms.

Results: Mn improved the contrast not only in T1W but also in T2W MRI. In general, however, Gd-enhanced T1W MRI provided the best contrast-to-noise ratio between layers. In Mn-enhanced T1W (12 min), T2W (161 min), or Gd-enhanced T1W (12 min) MRI of the hippocampus at 30x30x300 μm3, the mean CNR was 5.6, 5.2, or 6.1, respectively. Gd shortened the mean T1 of the olfactory bulb and the hippocampus from 1.48 s and 1.59 s to 0.43 s and 0.42 s, respectively.

Discussion: The present work shows Mn-enhanced T2W MRI and Gd-enhanced MRI of cellular layers. The observed pattern of Gd enhancement is in excellent agreement with the expected extracellular space of the tissue while the Mn enhancement partly differs from the expected intracellular space of the tissue.

Conclusion: Mn- as well as Gd-enhanced MRI provides new insights in histology and radiology of the brain in vivo.

References: