# In vivo MEMRI of the visual projection of mice using a clinical 3T whole body scanner

**K-H. Herrmann[1], A. Kretz[2], R. Haenold[3], I. Krumbein[4], F. Weih[3], O. W. Witte[2], and J. R. Reichenbach[1]**
[1]Medical Physics Group, Department of Diagnostic and Interventional Radiology I, Jena University Hospital, Jena, Germany, [2]Clinic of Neurology, Jena University Hospital, Jena, Germany, [3]Research Group Immunology, Leibnitz Insitute for Age Research, Jena, Germany, [4]Department of Diagnostic and Interventional Radiology I, Jena University Hospital, Jena, Germany

## Introduction

The visual system of rodents is a reliable model to study degeneration and regeneration of CNS axonal projections. In MEMRI experiments with rats [1,2] and mice [3], it was shown that the visual projection (VP) or olfactory system can be delineated using dedicated high field animal MR scanners. However, many clinical research facilities do not have easy access to such a dedicated scanner. This work demonstrates that functional MEMRI studies on mice can also be performed on a 3T clinical whole body scanner in combination with dedicated, commercially available RF coils.

## Materials and Methods

Adult anaesthetized C57BL/6 mice underwent either unilateral squeezing of the optic nerve or no injury (control). Prior to the MR scans all mice were deeply anaesthetized and intravitreally injected with 2 µl of a 15 nmol $MnCl_2$-solution. To analyse the kinetic behavior of the $Mn^{2+}$ along the VP, MR scans were conducted after 6, 12, 24, 48, 72 and 120 hours. The MR scans were performed on a 3T clinical whole-body scanner (Magnetom TIM Trio, Siemens Healthcare, Germany) using a commercially available, linearly polarized transmit/receive Litz coil (Doty Inc., USA) [4] with an inner diameter of 38 mm and an axial FoV of 33 mm. The sequence used was a 3D FLASH (VIBE) with isotropic resolution of $(0.2\ mm)^3$, TE/TR/α=6.5ms/16ms/22°, a bandwidth of 444 Hz/px. Six averages were acquired with total scan time of 35 min. A ROI based contrast-to-noise (CNR) analysis was conducted using the ROIs marked by the white arrows in Fig 2. CNR was determined as the signal difference between an enhancing structure and an adjacent non-enhancing brain area divided by the standard deviation of the background noise.

## Results

Figure 1 shows MIPs of the entire visual projection in a mouse in two orientations. From retina to the chiasm, the tracer signal appeared strong and distinct, and Mn2+ propagation to thalamic areas including the LGN and SC was clearly discernable in spite of a lower contrast level. The crushed nerve (6) showed a complete lack of enhanced signal distal to its injury site. Single slice images of the enhancing areas of the VP are shown in Figure 2. The time courses of the $Mn^{2+}$-transport in the optic nerve, LGN and SC are shown in Fig. 3. The optimum contrast of these $Mn^{2+}$-enhanced structures and adjacent non-enhancing brain tissue was reached between 12 and 24 h after $Mn^{2+}$-injection. There was, however, a difference in maximum contrast enhancement between the optic nerve (peak at ~12h) and the LGN and SC (peak at ~24h). The CNR of the optic nerve also recovered faster to its native value (72h), whereas it took more than 120h for $Mn^{2+}$ to be fully cleared from LGN and SC.

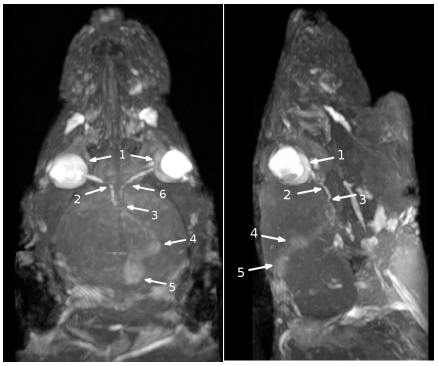


*Fig 1: Maximum intensity projections (MIP) of MEMRI images acquired 24h after $Mn^{2+}$ injection. The arrows point to retina (1), intact optic nerve (2), chiasm (3), lateral geniculate nucleus (LGN) (4), superior colliculus (SC) (5), and the unilateral crush of the optic nerve (6).*

## Discussion and Conclusions

MEMRI on a clinical 3T whole-body scanner is highly useful for high quality imaging of the visual projection in mice. The only additional hardware required was a dedicated small animal coil to achieve the necessary SNR. The coil which was used here was originally designed for a rat head. Using an even smaller coil designed for a mouse head might have improved the signal-to-noise by a factor of 2. The applied optimal concentration of 15nmol $MnCl_2$ is one order of magnitude lower than the concentrations recommended for rats [1]. Furthermore, compared to similar studies on rats [1], the time course of the $Mn^{2+}$ wash-out appeared to be twice as fast. In conclusion, this initial feasibility study encourages further research of pathologies of isolated CNS projections and phenotypes of genetically modified animals and thus to understand regeneration capabilities of axons.

**References:**
[1] Thuen M, et al. JMRI 2005;22(4):492ff.
[2] Thuen M, et al. JMRI 2008;28(4):855ff.
[3] Pautler RG. NMR in Biomed 2004;17:595ff
[4] Doty FD, et al. NMR Biomed 2007;20(3):304ff

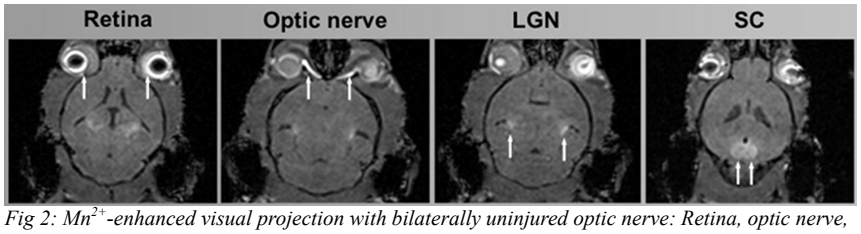


*Fig 2: $Mn^{2+}$-enhanced visual projection with bilaterally uninjured optic nerve: Retina, optic nerve, LGN and SC. The arrows mark the signal ROIs used for the CNR analysis (see Fig. 3).*

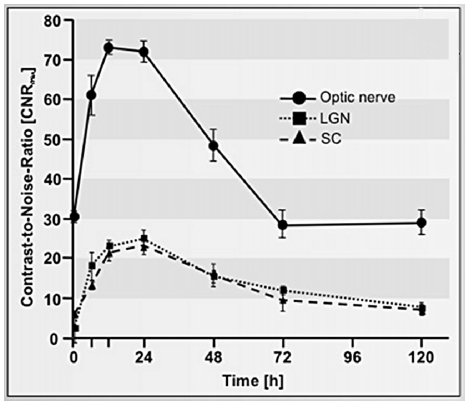


*Fig 3: Time course of the Mn-enhancement.*