# Evaluation of astrocytic brain tumors with 7T versus 1.5T MRI

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*INTRODUCTION:* The objective of our study was to characterize intracranial gliomas by 1.5T MRI in comparison to 7T MRI. By taking advantage of the increased signal-to-noise ratio (SNR), spatial resolution, and susceptibility effects of a 7T whole-body MR system a superior visualization of intracranial tumors compared with that of 1.5T systems should be achieved. The aim of this study was to determine whether 7T MRI is superior to 1.5T MRI in the visualization of different tumor constituents. Especially the microvascularity within these masses will be evaluated and compared.

*METHODS:* Twelve patients with 12 untreated and after imaging histologically confirmed, astrocytic brain tumors (WHO grade II-IV) underwent 1.5T (Sonata, 1.5T whole-body scanner, Siemens, Erlangen, Germany) and 7T MRI (Magnetom 7T whole-body scanner, Siemens, Erlangen, Germany). 7T images were achieved either using a CP head coil (InVivo Corp., Gainesville, FL) or an 8-channel head coil (Rapid, Wuerzburg, Germany). A clinical standard protocol at 1.5T was compared to a scientific, high-resolution protocol at 7T to achieve T1 (3D MPRAGE, VIBE), T2, PD (2D turbo spin echo) and T2* (2D gradient echo, 3D SWI) weighted images in sagittal and transversal orientations. The localization of gliomas and the depiction of microarchitecture and tumor constituents were evaluated at both field strengths.

*RESULTS:* A total of 12 supratentorially located masses (glioblastoma, n=6; anaplastic astrocytoma, n=4; diffuse astrocytoma, n=2) were detected among 12 patients studied by 1.5T and 7T MRI. Besides physiological, penetrating vessels in the gray and white matter, 7T gradient echo sequences superiorly or even solely depicted disorganized areas of signal intensity loss within the tumoral bed in 8 of 10 high-grade gliomas. These inhomogeneities are assumed to represent areas of increased microvascularity or microhemorrhages, respectively. Especially 7T T2* weighted images revealed both features in anaplastic astrocytoma and glioblastoma, that could not be appreciated by 1.5T MR systems and were not found in two patients with low-grade astrocytoma. This first 7T MRI study of a larger group of brain tumor patients confirms the improved visibility of tumor vasculature found in post mortem and angiographic, single-patient studies [1, 2]. The higher spatial resolution at 7 T resolves the disrupted, internal microarchitecture of these brain tumors that could not be appreciated by the conventional lower field MR system. Image quality of 7T gradient-echo imaging was moderately hampered by local magnetic field inhomogeneities close to the skull base and chemical shift artefacts.

*CONCLUSIONS:* Our preliminary results indicate that 7T MRI is feasible and useful in the detection and visualization of primary brain tumors. 7T MRI superiorly resolves assumed microvascularity and microhemorrhages within astrocytic brain tumors due to the higher spatial resolution and increased susceptibility for deoxyhemoglobin. This finding could indicate a higher sensitivity to malignant transformation, which will have to be investigated in further patients.

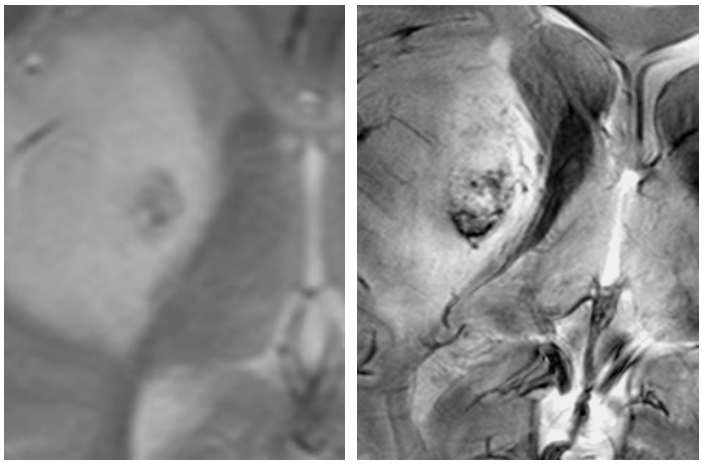

Figure: Axial T2* weighted images of an anaplastic astrocytoma (WHO grade III) in the right putamen of a 33-year-old, female patient. In comparison to the 1.5T image (left; voxel size: 1.2x0.9x6.0 $mm^3$), the 7T image (right; voxel size: 0.5x0.5x3.0 $mm^3$) shows more hypointensive microstructure in the tumoral bed representing assumed microhemorrhages. The pallidum is depicted more hypointensive at 7T due to the increased susceptibility for the physiological iron content.

References

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2. Christoforidis, G.A., et al., *Susceptibility-based imaging of glioblastoma microvascularity at 8 T: correlation of MR imaging and postmortem pathology.* AJNR Am J Neuroradiol, 2004. **25**(5): p. 756-60.