In vivo Glioma Characterization using MR Conductivity Imaging

T. Voigt[1], O. Väterlein[2], C. Stehning[1], U. Katscher[1], and J. Fiehler[2]
[1]Philips Research Laboratories, Hamburg, Germany, [2]Department of Neuroradiology, University Medical Centre Hamburg-Eppendorf, Hamburg, Germany

Introduction:

Electric Properties Tomography (EPT) is a method for quantitative imaging of dielectric properties of tissue using standard MRI sequences [1]. The EPT method is based on the measurement of the complex active component of the excitation field (B1) [2, 3]. Recently, accelerated conductivity imaging based on phase imaging only was introduced and successfully tested with healthy volunteers [4, 5].

In this study, we report first practical experiences of conductivity imaging in patients with brain glioma in a real-world clinical environment. *In vivo* conductivity of glioma is measured and quantitative values are compared with white matter conductivities of healthy volunteers. Glioma conductivity was found to be significantly higher than healthy white matter conductivity.

Methods:

Two patients with brain glioma were investigated as well as 5 healthy volunteers. All scans were conducted on a 1.5T scanner (Philips Healthcare, Best, The Netherlands) in a clinical environment. For phase-based conductivity imaging, a 3D TSE scan was used for phase mapping (FOV 210 × 200 × 189 mm³, resolution 1.8 × 1.8 mm² in-plane, 5 mm slice thickness, TR / TE = 400 / 5.4 ms, turbo factor 3, total scan time 6:20 min). Conductivity reconstruction was performed according to the reconstruction formula derived in [4]. Average values for conductivity were computed inside manually delineated white matter and glioma regions of interest.

Results and Discussion:

Average conductivity values for white matter of healthy volunteers and patients with glioma are shown in Tab. 1. The average white matter conductivity was 0.36 ± 0.05 S/m in healthy volunteers. Glioma conductivity was significantly higher at 1.0 ± 0.04 S/m. Conductivity images of the two patients investigated are shown in Fig. 1.

It is expected that white matter tissue structure affected by glioma is significantly altered. Cell conductivity at MR Larmor frequency is determined by the composition of intracellular cytoplasm. Our findings of enhanced conductivity in glioma suggest an alteration of tissue composition, like vasculature, and/or alteration the cell interior, e.g. salt, water, or protein content compared with healthy white matter tissue.

Conclusions:

Image acquisition protocols and post-processing have been established in a routine clinical environment. First clinical results are presented and *in vivo* conductivity of glioma is measured and compared with healthy white matter conductivity. First hints towards altered tissue composition and/or cellular constituents in glioma tissue are obtained via this new image contrast. In future work, the patient basis has to be extended and the cause of enhanced glioma conductivity has to be confirmed in histology.

References:

[1] Katscher et al., Trans Med. Imag.;28,2009. [2] Haacke et al., Phys. Med. Biol.;36,1991. [3] Wen, Proc. SPIE;p.471,2003. [4] Voigt et al., Proc. ISMRM;p.2865,2010. [5] van Lier et al., Proc. ISMRM;p.2864,2010.

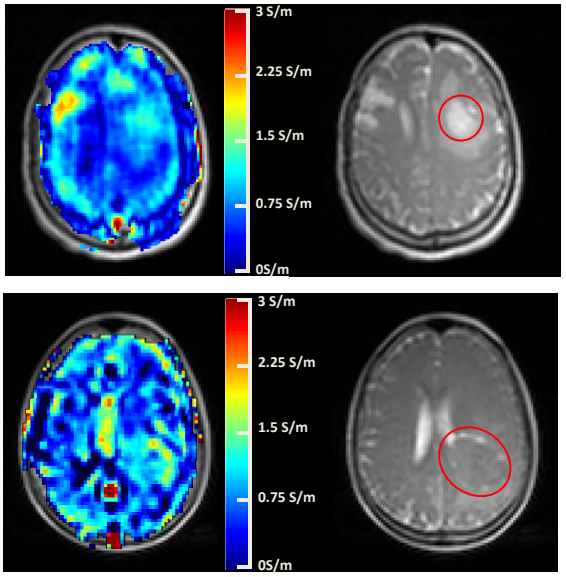

Figure 1: *In vivo* conductivity maps of patients with gliomas (circles). Patient 1 (above) had a previous lesion excised on the opposite side. Patient 2 is shown below.

Conductivity Imaging [S/m]	
Healthy volunteers	White matter ROI
1	0.43 ± 0.15
2	0.33 ± 0.11
3	0.37 ± 0.15
4	0.37 ± 0.23
5	0.3 ± 0.18

Patients	Glioma ROI
1	0.97 ± 0.18
2	1.02 ± 0.37

Table 1: Quantitative conductivity values of white matter in healthy volunteers and glioma in two patients. Corresponding images are shown in Fig. 1.