

# Quantitative Magnetization Transfer Imaging in Acute Stroke: A Follow Up Study Correlating Quantitative MRI With Respect of Severity of Stroke

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**Introduction:** Magnetization transfer (MT) imaging can potentially serve as a marker for loss of tissue integrity (1). Increased pathologic specificity is expected from quantitative MT (qMT) as compared to the assessment of the semi-quantitative MT ratio (MTR) images only. However, limited resolution or long acquisition times have so far impeded qMT imaging in severe acute stroke. Quantitative MT with balanced steady state free precession (bSSFP) sequences has overcome these problems (2,3) and yields the bound pool fraction F, the exchange rate kf, relaxation times of the free pool T1 and T2, as well as MTR. Here, we present an evaluation of qMTI data over three consecutive MRIs within the first 10 days for patients suffering from middle cerebral artery stroke with different progression of symptoms

**Methods:** Imaging was performed on a clinical 1.5 T system (Siemens Avanto). Patient 1 (female, age 88y) and patient 2 (male, age 60y) underwent three consecutive cranial MRI exams: First MRI (MRI1) 6 h, second MRI (MRI2) 3-4 d and third MRI (MRI3) 9-10 d after symptoms onset. The clinical protocol included DWI, T2w, FLAIR, T2\*w and TOF-MRA. Quantitative MTI included a B1 map, two RF spoiled gradient echo sequences with variable flip angles for T1 determination (4), two bSSFP sequences with variable flip angles for T2 determination (4) and seven bSSFP sequences using different RF pulse durations (TRF = 230µs - 2100µs) to yield F and kf (5). Data acquisition time for the whole qMTI protocol was 10 minutes. Images were registered prior to data analysis using FSL (*FSL Tool, Oxford, UK*). A region of interest (ROI2, Fig. 1) in the diffusion restricted area and in the contralateral normal appearing parenchyma (ROI1, Fig. 1) were identified in the first MRI scan and were drawn manually by an experienced radiologist for each patient and copied to the subsequent scans. Mean values and standard deviations within each ROI were calculated for all qMT parameters and were normalized to the initial scan.

**Results:** DWI and exemplary maps of MTR, F and kf with corresponding ROIs in normal appearing and pathologic tissue are shown in Fig. 1 and the progression of assessed quantitative parameter values are shown in Fig. 2. In addition, values from the initial scan are given in Table 1. Results in healthy appearing tissue remained constant over time (Fig. 2a,c). In MRI1 both patients showed a pathologic increase in T1 and T2, a pathologic decrease in F and kf and a minimal decrease in MTR (Fig. 2b,d). For patient 1, who presented with worsening symptoms, an aggravation of qMTI values in MRI2 and MRI3 are observable (Fig. 2b), while in patient 2, who was recovering, qMTI values showed a normalisation (Fig. 2d). In contrast to the quantitative parameters, the MTR changed only slightly (80-100% relative to the contralateral hemisphere) and did not suggest different progressions in the two patients.

**Discussion & Conclusion:** Characterization of acute cerebral ischemia with respect of severity is of major clinical relevance. We present first qMTI results in cerebral ischemia based on a bSSFP protocol. Quantitative MT parameters might deliver advanced information about tissue integrity. They seem to be superior to simple MTR measurements and possibly allow for early statement of prognosis and efficacy of therapeutic methods.

## References:

(1) Tourdias et al., Stroke 2007; (2) Bieri et al., MRM 2007; (3) Gloor et al., MRM 2008 ; (4) Deoni et al., MRM 2005 ; (5) Gloor et al., Proc. ESMRMB 2008

	F [%]	kf [s <sup>-1</sup> ]	T1 [ms]	T2 [ms]	MTR [%]
Pat.1	12.1 ± 3.5	2.9 ± 0.4	882 ± 49	72 ± 5	39.9 ± 1.6
Pat.2	13.0 ± 3.1	3.2 ± 0.5	824 ± 72	67 ± 7	41.6 ± 1.5

Tab. 1: Mean values and standard deviation of quantitative parameters in ROI1 for the first time point.

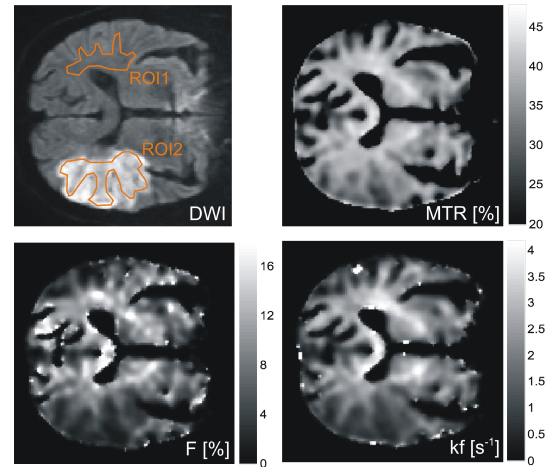


Fig. 1: Exemplary DWI, MTR, F and kf maps from the initial MRI scan of patient 2. Regions of interest in contralateral normal appearing parenchyma (ROI1) and diffusion restricted region (ROI2) are marked on the DWI.

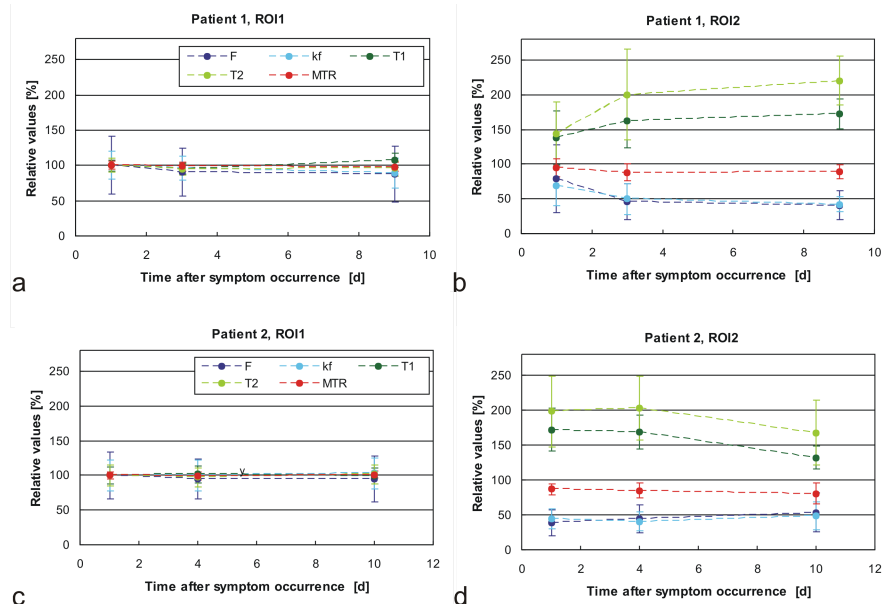


Fig. 2: Mean values and standard deviation of quantitative parameters in ROI1 in relation to the first time point (100%) for patient 1 (a) and patient 2 (c). Values of ischemic tissue (ROI2) in relation to values of the contralateral hemisphere (100%) for the corresponding time point for patient 1 (b) and patient 2 (d).