Combined Visualization of ADC Diffusion Maps and CBV Perfusion Maps in Patients with Newly Diagnosed Glioblastoma

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Target Audience: Physicians and scientists interested in the field of advanced brain tumor imaging

Introduction:
Diffusion MRI (DWI) and dynamic-susceptibility-contrast weighted perfusion MRI (DSC) have been proposed to distinguish areas of different malignancy in heterogeneous tumors such as glioblastoma.(1,2) It is presently unclear if the regions identified by these two different imaging methods are overlapping. The aim of this study was to coregister ADC and CBV maps to evaluate, whether or not areas of minimum ADC and maximum CBV are congruent.

Methods
DWI, DSC (TE 35, TR 1920, FoV 240, slice thickness 5 mm, 75 dynamic scans, injection of 0,1 mmol/kg DOTAREM with bolus technique after the third dynamic scan) and contrast-enhanced T1-w Imaging was performed in 20 patients with newly diagnosed and histologically proven glioblastoma before surgery on a 3 Tesla MR-system. Prior to DSC, a contrast agent bolus (DOTAREM) was injected as pre-load. ADC and CBV maps were calculated using Siemens Syngo-Software. Afterwards, the acquired maps were coregistered on the T1-w image, and thresholds of CBV and ADC were visualized using a specially developed software based on MeVisLab (Fraunhofer MEVIS, Bremen, Germany). A region of interest was manually delineated on T1-w images encompassing the enhancing lesion including a 1 cm margin. Within this ROI, pixels with ADC < the 30th percentile (minADC), pixels with CBV > the 70th percentile (maxCBV) and the corresponding overlap were automatically calculated and visualized on the T1-w images (figure 1). Additionally, 2 experienced neuroradiologists independently evaluated whether minADC, maxCBV and the overlap were located within the enhancing lesion on corresponding T1-w images or within the area surrounding the enhancing lesion.

Results
MinADC- and maxCBV-areas showed an average overlap of 34.7 +/- 10.9 percent within the thresholded area. In 14 of 20 patients maxCBV areas were located mostly within the enhancing region whereas minADC areas were located in the surrounding area. In 6 patients there was no significant distribution of minADC and maxCBV areas within the enhancing or the surrounding tissue.

Discussion and Conclusions:
Our study provides evidence, that diffusion- and perfusion-imaging visualize different aspects of tumor biology, that do not necessarily overlap spatially. Generally, low ADC-values reflect high cellularity whereas high CBV-values are consistent with increased vascularity. A possible explanation for the different location of the maxCBV areas located mainly within the enhancing area and the minADC areas located within the surrounding tissue could be that migrating tumorcells in the invasion-front, represented by areas of low ADC-values, produce and secrete neoangiogenic factors, leading to a "trailing behind" of the vascular-rich tumor border, represented by high CBV-values. Further studies, especially correlations with biopsies are needed to determine the exact correlation between ADC-, CBV-values and malignancy.

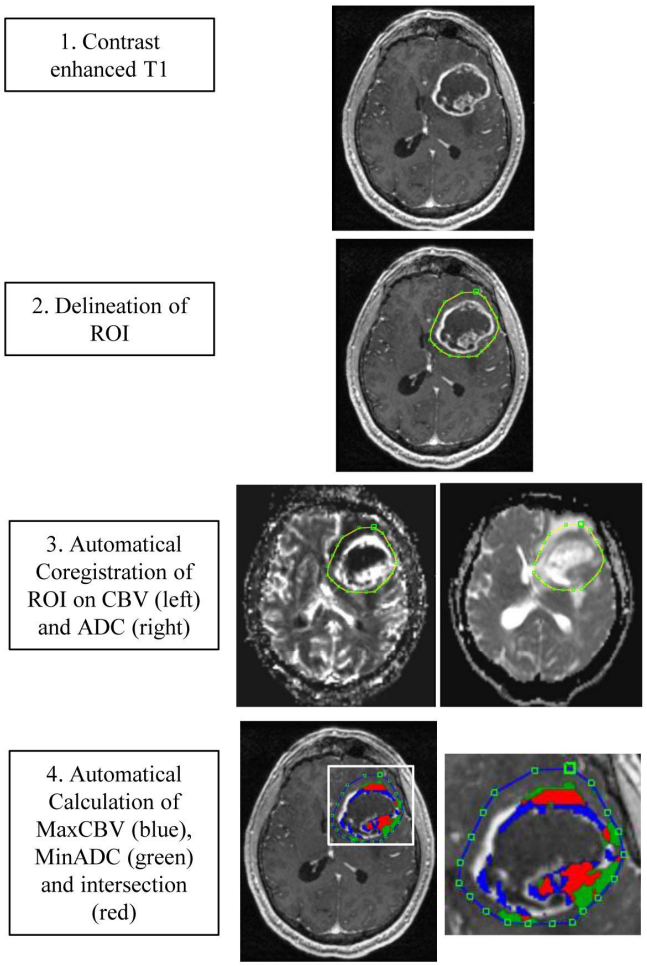

Figure 1: Illustration of the post-processing

References:

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2. Kono K, Inoue Y, Nakayama K, Shakudo M, Morino M, Ohata K, Wakasa K, Yamada R. The role of diffusion-weighted imaging in patients with brain tumors. AJNR Am J Neuroradiol 2001;22(6):1081-1088.