

DIFFUSIONAL KURTOSIS IMAGING INDICATING VARIOUS TISSUE OF GLIOBLASTOMA; VOXEL-BY-VOXEL STUDY

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Background and Purpose: Diffusional kurtosis imaging (DKI) has been highlighted as a new technique based on non-Gaussian water diffusion analysis [1, 2]. Although recent studies have reported values of diffusional MR imaging in glioma grading [3, 4], underlining microstructural changes corresponding to changes of diffusion metrics are not fully elucidated. This study investigated differences in DKI metrics among different components within glioblastoma, by means of voxel-by-voxel analysis.

Methods: Four patients with histologically proven cerebral glioblastoma were included in this study (three women, one man; mean age, 49 years; range, 33-70 years). DKI data were acquired using a 3-T MR imager (Achieva; Philips Medical Systems), using single-shot, spin-echo EPI sequence, with MPG applied in 32 uniformly distributed directions. The other parameters were: TR/TE, 3000/80 msec; field of view, 256 x 256 mm; matrix, 128 x 128; section thickness, 5 mm; 6 b-values (0, 500, 1000, 1500, 2000, and 2500 sec/mm²), and DELTA/delta, 39.0/28.0 ms. The maps of fractional anisotropy (FA), apparent diffusion coefficients (ADC) and mean kurtosis (MK) were generated. Regions of interest (ROIs) were manually drawn in “contrast-enhanced parts of tumor (solid part)”, “necrotic area (necrosis)”, “peritumoral area (peritumor)”, and “contralateral normal white matter (normal WM)”, in reference to T2-weighted images and contrast-enhanced T1-weighted images. The FA, ADC, and MK values within each ROI were plotted voxel-by-voxel.

Results: Scattered plot of FA and MK (Fig 1) showed positive linear correlation except for “solid part”. The “solid part” of tumor showed higher MK/FA than other components. Scattered plot of ADC and MK (Fig 2) showed negative linear correlation or inverse proportional pattern. Though “solid part” and “peritumor” were indistinguishable solely by ADC, the “solid part” tended to have higher MK compared with the “peritumor”. Moreover, it seemed that there were two components within the “peritumor”, possibly reflecting tumor infiltration and peritumoral edema.

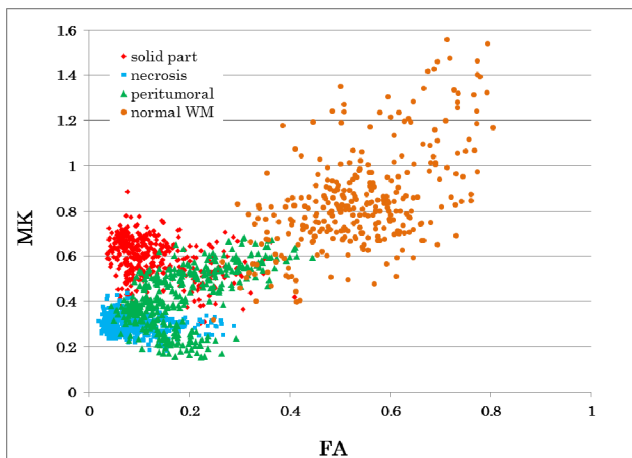


Figure 1. A scattered plot that shows FA in horizontal axis, MK in vertical axis for each tissue.

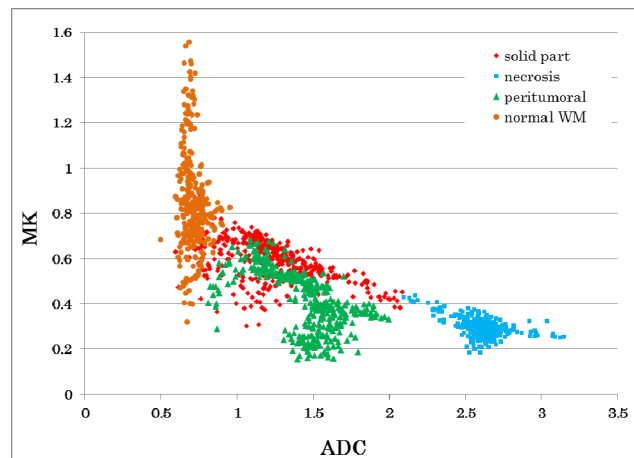


Figure 2. A scattered plot that shows ADC in horizontal axis, MK in vertical axis for each tissue.

Discussion: Voxel-by-voxel scattered plots of different diffusion metrics enabled discrimination of different tissue components in glioblastoma. Although the combination of diffusion metrics for tissue characterization needs to be optimized by further investigation including pathological correlations, this method might be informative in tumor grading or in differentiation of tumor infiltration from peritumoral edema.

Conclusion: Voxel-by-voxel analyses give us insight and better understanding of changes in diffusion metrics of different tissue components of glioblastoma.

References: 1. Jensen JH et al. MRM 2005;53:1432-1440 2. M Hori et al. Magn Reson Med Sci. 2012;11:221-233. 3. Raab P et al. Radiology. 2010;254:876-881. 3. Van Cauter S et al. Radiology. 2012;263:492-501.