Diffusion-Tensor Imaging of Cerebral Glioma at 3 T MRI: Analysis of Fractional Anisotropy and Mean Diffusivity

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Background and Purpose

Fractional anisotropy (FA) reflects the degree of white matter's disruption or displacement by tumor infiltration in cerebral glioma. The purpose of this study is to determine whether FA or mean diffusivity (MD) at 3T diffusion-tensor imaging (DTI) is different between low-grade and high-grade glioma, and to compare FA and MD values in the regions of enhancing tumor, non-enhancing tumor, peritumoral T2 hyperintense area in high-grade gliomas.

Methods

DTI and conventional MR imaging including T2- and enhanced T1- weighted images were obtained in 27 patients with cerebral gliomas (high-grade gliomas, 18; low-grade gliomas, 9). Values of FA, MD, T2 signal intensity were measured at four ROIs of enhancing tumor (1st ROI), non-enhancing tumor (2nd ROI), non-enhancing peritumoral bright signal region (3rd ROI) and contralateral subcortical white mater (4th ROI) after coregistration of all images using SPM2 software (Figure1). We compared values of FA, MD, and T2 signal intensity of non-enhancing infiltrative tumors between low - and high-grade gliomas, and those values among four ROIs in high-grade gliomas. Student t-test and Pearson correlation coefficient were used for statistics.

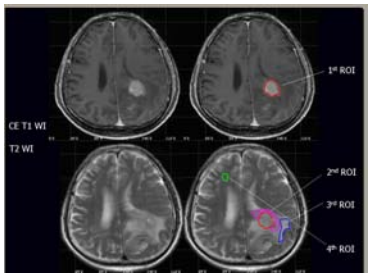

Figure1. Four ROIs of enhancing tumor, non-enhancing tumor, non-enhancing peritumoral T2 bright SI region, and contralateral white matter

Results

In comparison of non-enhancing lesions between low- and high-grade gliomas, mean MD values were statistically significantly higher in low-grade gliomas than those in high-grade gliomas (1624.9±420.6 and 1218.2±331.1, respectively, p=0.02) and mean FA values were not significantly different between low-grade and high grade gliomas (0.169±0.085 and 0.220±0.087, respectively, p=0.19). In high-grade gliomas, mean FA values of 3 ROIs were significantly lower ($p < 0.002$), and mean MD values of 3 ROIs were higher than those of contralateral white matters ($p \leq 0.02$). In comparison of three ROIs in high-grade gliomas, FA values of non-enhancing tumors were higher than those of enhancing tumors with statically significance (p=0.03), but FA values of non-enhancing peritumoral bright SI regions were not significantly different from enhancing or non-enhancing tumor (table1). MD values of non-enhancing peritumoral T2 bright regions were significantly higher than those of non-enhancing tumor (p=0.007). There was no significant relationship among T2 signal intensity, FA, and MD values.

Conclusion

Although MD values were significantly different between low-and high-grade gliomas, FA values were not significantly different and not useful for differentiating low-grade from high-grade glioma. In high grade gliomas, FA value of enhancing tumor was significantly lower than non-enhancing tumor or peritumoral T2 bright regions, but FA values were not different between non-enhancing tumor and non-enhancing peritumoral T2 bright region. The higher mean MD value of non-enhancing peritumoral T2 bright regions than that of non-enhancing tumor suggests that decrease of FA value may reflect not only white matter's disruption by tumor infiltration but also expansion of extracellular space due to vasogenic edema. Therefore, distinction between vasogenic edema and tumor infiltration only by FA value is difficult at 3T DTI.

Table 1. FA and MD values of 4 ROI Regions in High Grade Gliomas (n=18)

	Enhancing tumor	Non-enhancing tumor	Peritumoral T2 bright signal region	Contralateral WM
FA	0.165±0.085	0.220±0.087	0.201±0.079	0.361±0.104
MD (μm2/sec)	1372.7±422.7	1218.2±331.1	1545.2±344.5	999.8±273.5