Multiparametric Analysis for Differentiating Tumor Recurrence from Radiation Effect

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Introduction

Despite aggressive and combined therapeutic regimes, brain tumors generally recur. It is often difficult to differentiate tumor recurrence from radiation related changes because these two entities exhibit similar features on conventional magnetic resonance imaging (MRI)[1]. The aim of present study was to perform multiparametric analysis to differentiate tumor recurrence from radiation effect in a series of patients with brain tumors who had been treated previously with surgery, radiotherapy, and chemotherapy.

Methods

Eight patients with biopsy proved tumor recurrence and 6 patients with radiation effect were included in this study. MR study was performed on a 3.0 T whole body scanner. The MRI protocol included anatomical sequences with and without contrast agent, diffusion tensor imaging (DTI) with 12 directions (TR/TE=4200/83ms, b = 0 and 1000 s/mm^2, slice thickness=3mm, iPAT mode=GRAPPA, acceleration factor=2), perfusion weighted imaging (PWI) using gradient echo sequence (TR/TE=200/45ms, number of slices=20, slice thickness=3mm) and multivoxel proton magnetic resonance spectroscopic imaging (^{1}H MRSI) using a spin echo sequence (TR/TE/NEX =1700/30ms/3, matrix size=16x16, FOV16x16cm^2). To analyze the data, apparent diffusion coefficient (ADC), fractional anisotropy (FA) and cerebral blood volume (CBV) maps were generated and were co-registered with post contrast (PC) T1-weighted MPRAGE images using the SPM software. Region of interests (ROIs) were drawn manually on contrast-enhanced areas from all slices of the PC T1-weighted images and ADC, FA and CBV values were measured from these ROIs. ^{1}H MRSI data was analyzed from voxels that encompassed contrast enhanced regions and also from regions that were one voxel further away from the contrast enhancing areas towards the normal brain. Concentration of choline (Cho), creatine (Cr) and lipid+lactate (Lip+Lac) were measured using LC Model software and were reported as Cho/Cr and Lip+Lac/Cr. A two-tailed heteroscedastic Student t-test was performed to look for any significant difference for DTI, PWI and ^{1}H MRSI Indices between patients with tumor recurrence and radiation effect. A p value of less than 0.05 was considered as significantly different.

Results

The summary of the results is presented in Table 1. Significantly higher CBV values were observed from patients with a tumor recurrence compared to patients with radiation effect. However, no significant difference was observed in any of the DTI indices between the two groups. Spectroscopic results showed the difference from only the contrast enhancing areas whereby an increase in Lip+Lac/Cr ratio was observed from patients with radiation effect compared to tumor recurrence (Fig. 1).

Table1: Mean and standard error of DTI, PWI and ^{1}H MRSI indices between patients with tumor recurrence and radiation effect

Category	**Contrast enhanced region**		**Regions beyond contrast enhancement**		**Contrast enhanced region**		
	Cho/Cr	**Lip+Lac/Cr**	**Cho/Cr**	**Lip+Lac/Cr**	**ADC (x10^{-3} mm^2/s)**	**FA**	**CBV**
Tumor Recurrence (n=8)	0.67±0.08	8.64±2.29	0.49±0.09	5.46±1.04	1.20±0.06	0.16±0.02	1727.8±231.98*
Radiation Effect (n=6)	0.51±0.06	20.36±3.43*	0.39±0.05	6.41±0.70	1.31±0.04	0.17±0.01	885.88±92.85

*Significant different indices between two groups

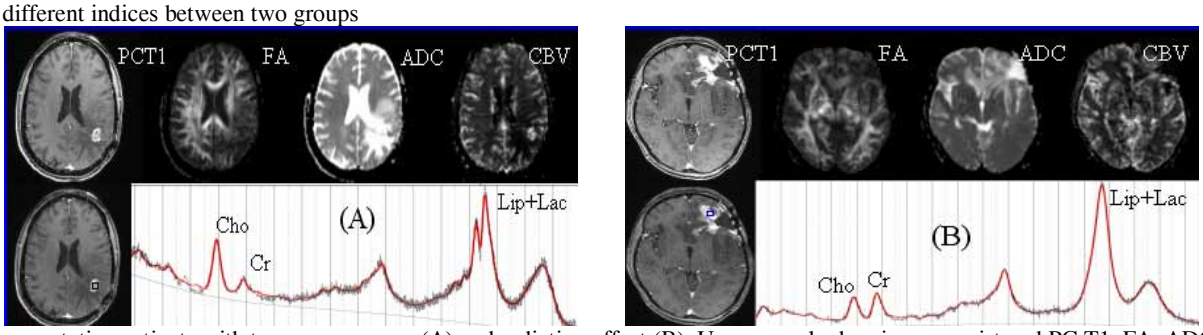

Figure 1: Representative patients with tumor recurrence (A) and radiation effect (B). Upper panels showing co-registered PC T1, FA, ADC and CBV maps. Lower panels showing proton spectra exhibiting various metabolites from the voxels shown on PC T1.

Discussion and Conclusion

The ability to differentiate patients with tumor recurrence from radiation effect is an important clinical issue. Our preliminary results show that high Lip+Lac/Cr and low CBV in patients with radiation effect may be helpful for differentiating them from tumor recurrent patients. Differences may be due to the reason that radiation damage to the tissue is characterized by degenerative vascular changes followed by necrosis of brain parenchyma[2].

References

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