Tissue Assessment in Gliomas: Comparison of Tumor Blood Volume, Vascular Permeability by Perfusion-Weighted MR Imaging and Tl-201 SPECT

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Introduction

Thallium-201 (Tl-201) uptake levels are useful in assessing the glioma. Factors involved in Tl-201 uptake after intravenous injection of Tl-201 include blood supply (blood volume), disruption of the blood-brain barrier (vascular permeability), and preservation of Tl-201 inside the tumor cell. However, the major contributor to Tl-201 uptake has not been clearly documented. Perfusion-weighted MRI (PWI), which provides blood volume and vascular permeability information, allows us to evaluate the degree of glioma malignancy. We hypothesized that increased tumor blood volume could be responsible for the corresponding Tl-201 accumulation. In this study, we compared the tumor blood volume, vascular permeability information provided by PWI and the level of Tl-201 uptake.

Methods and Materials

Nine patients with glioblastoma multiforme (GBM) were included. Early (15 min post-injection) and delayed (3 hr) scan images were acquired after Tl-201 administration. PWI was performed on a 1.5T MR scanner using a double-echo gradient-echo sequence to obtain a T1-bias-free estimate of the time-concentration curve. For Tl-201 images, Tl-201 uptake ratios of tumors to contra-lateral normal white matter (T/N ratio) were calculated for both the early and delayed scans. For PWI, index of tumor blood volume and index of vascular permeability (K(trans)) were calculated. For the quantitative data analysis, we compared both T/N ratio (early) and T/N ratio (delayed) with the index of tumor blood volume and K(trans).

Results

In the quantitative analysis, the T/N ratio (early) varied from 3.2 to 16.1 (mean ± SD: 7.6 ± 4.4). The T/N ratio (delayed) varied from 2.0 to 8.4 (4.9 ± 2.6). The index of tumor blood volume varied from 1.0 to 6.8 (3.2 ± 1.7). The K(trans) varied from 0.001 to 0.63 (0.29 ± 0.37). The T/N ratios (early) were well correlated with the index of tumor blood volume (Figure 1, $r^2 = 0.68$, $p < 0.01$). In the delayed image, there was also significant positive correlation between T/N ratios and the index of tumor blood volume ($r^2 = 0.65$, $p < 0.05$). However, no significant correlation between T/N ratio and K(trans). In the visual assessment, the degree of tumor blood volume on the parametric map was concordant with the degree of Tl-201 uptake in both early and delayed Tl-201 images (Figure 2).

Discussion and Conclusion

In this study, significant correlation between T/N ratios and the index of tumor blood volume was demonstrated on both early and delayed Tl-201 images. In other words, the higher the blood volume is, the higher the Tl-201 uptake is. However, no significant difference was observed between Tl-201 uptake and K(trans). Although preservation of Tl-201 inside the tumor cell was not discussed in this study, our results support the hypothesis that increased tumor blood volume is at least one of the responsible factors for the corresponding Tl-201 accumulation.

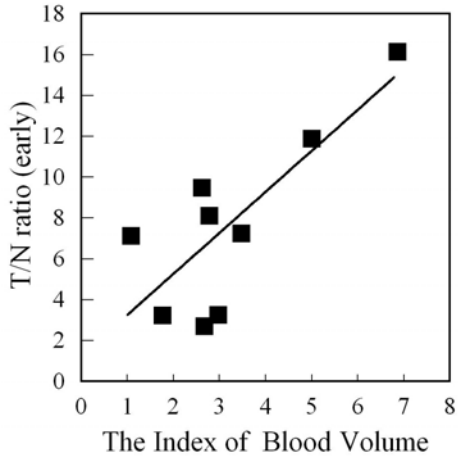

Figure 1.
The T/N ratios in the early scan were well correlated with the index of tumor blood volume ($r^2 = 0.68$, $p < 0.01$).

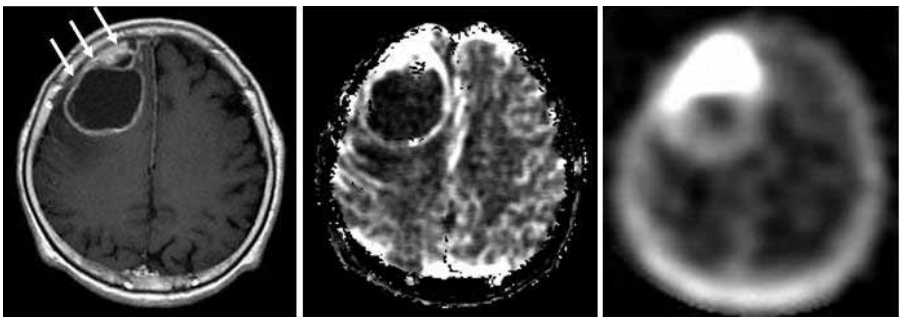

Figure 2. 85 F, GBM case
Contrast-enhanced T1-weighted SE image (left), blood volume map (middle), Tl-201 early image (right). The GBM is recognized as a strongly enhancing tumor in the right frontal lobe (white arrows). Note that the GBM displays a larger blood volume on the blood volume map. Corresponding high accumulation in early Tl-201 images is demonstrated.