Tumor blood volume: a prognostic biomarker for anaplastic astrocytomas?

“...perfusion MRI can be used to predict treatment response and determine optimal follow-up intervals for patients diagnosed with anaplastic astrocytoma.”

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Anaplastic astrocytoma is a WHO grade III glioma characterized by diffusely infiltrative astrocytic tumors with cytological atypia, anaplasia and mitoses [1]. Although histopathologic assessment remains the reference standard for tumor grading, sampling error, inter- and intra-pathologist variability, and heterogeneity of gliomas may result in inadequate evaluation [2,3]. In particular, grade III gliomas tend to be heterogeneous and may contain regions of different degrees of malignant degeneration within the same tumor [4]. Therefore, imaging studies can provide additional characterization.

While conventional MRI techniques can delineate the extent of the brain tumors, perfusion MRI can serve as an imaging biomarker. There are three main types of perfusion MRI techniques, including dynamic susceptibility contrast-enhanced magnetic resonance (MR) perfusion, dynamic contrast-enhanced MR perfusion and arterial spin-labeling MR perfusion [5]. Dynamic susceptibility contrast-enhanced MR perfusion consists of a bolus-tracking technique in which a bolus of gadolinium-based contrast agent through the brain is monitored by a series of T2- or T2*-weighted MRI

sequences. Dynamic contrast-enhanced perfusion MRI or permeability MRI is based on the acquisition of serial T1-weighted images before, during and after administration of contrast. Arterial spin-labeling MR perfusion uses magnetically labeled blood as an endogenous tracer and can be performed using continuous, pseudocontinuous or pulsed radiofrequency techniques.

Dynamic susceptibility contrast-enhanced MR perfusion in gliomas has been extensively studied and is used routinely in clinical practice. Using dynamic susceptibility contrast-enhanced MR perfusion, we recently investigated the perfusion characteristics of grade III tumors. Interestingly, there was no significant correlation ($p = 0.12$) between pretreatment tumor blood volume and progression-free survival for grade III tumors as a whole. However, further analysis revealed a significant correlation ($p = 0.01$) between pretreatment tumor blood volume and progression-free survival for the anaplastic astrocytoma subgroup. On the other hand, there was no significant correlation between pretreatment tumor blood volume and progression-free survival for oligodendroglial tumors [6]. Furthermore,

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we found that a cut-off tumor blood volume of 2.86 could predict progression-free survival of anaplastic astrocytomas above or below 446.5 days with 78% accuracy [6]. These results suggest that perfusion MRI can be used to predict treatment response and determine optimal follow-up intervals for patients diagnosed with anaplastic astrocytoma. However, the results of our study further emphasize that, despite having higher tumor blood volume, the prognosis in the anaplastic tumors with oligodendroglial components do not correlate with survival. Nevertheless, additional studies with larger sample sizes are necessary to confirm the utility of perfusion MRI for clinical management of patients with anaplastic astrocytoma. Furthermore, standardization of optimized perfusion MRI protocols across

different institutions is needed to facilitate implementation and interpretation of quantitative techniques. Currently, there is wide variability across institutions in the equipment and data-interpretation software that are available, and a lack of trial evidence to confirm the clinical benefit of novel MRI perfusion techniques [5].

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