Using rCBV and CBF to Distinguish Radiation Necrosis from Tumor Recurrence in Malignant Gliomas

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Introduction

Distinguishing radiation necrosis from tumor recurrence is a key aspect of post-radiation follow-up in patients with malignant gliomas. An area of enhancement on a CT or MR image could represent successful tumor destruction with necrosis of surrounding tissue or tumor recurrence. The diagnostic accuracy directly impacts decisions regarding additional therapy. The aim of the study was to determine if magnetic resonance perfusion imaging which allows the creation of relative cerebral blood volume (rCBV) and cerebral blood flow (CBF) maps could distinguish between viable tumor and radiation necrosis.

Materials and Methods

Twenty-four patients with either confirmed low grade gliomas (n=15) or radiation necrosis (n=9) underwent simultaneous gradient-echo/spin-echo (GE/SE) echo-planar imaging (EPI) during bolus gadolinium injection (0.20-0.25 mmol/kg). The effects of agent extravasation were minimized with a preload of contrast agent (0.05 mmole/kg) and a postprocessing correction algorithm as previously described (1). Image maps of total (GE) and microvascular (SE) rCBV and CBF were created. The CBF calculation was based on the SVD method (2) with leakage correction (3). Volumes of interest (VOI) were drawn based on the area of enhancement on post-contrast T1w images and normalized to contralateral, uninvolved white matter. An unpaired t-test was used to determine whether the normalized rCBV or CBF values of radiation necrosis could be distinguished from those in untreated low-grade gliomas. This comparison was chosen as a worst-case scenario since low-grade gliomas are known to have lower blood volume than high-grade gliomas.

Results and Discussion

Images from patients with radiation necrosis (Fig. 1) and a low-grade tumor (Fig 2) are shown below. Elevated CBV and CBF can be seen in the patient with the low-grade tumor and not in the patient with confirmed radiation necrosis. A significant difference was found between the normalized rCBV values for low-grade gliomas and radiation necrosis for SE ($p=0.02$), but not for GE ($p=0.31$). A significant difference was also found between the normalized CBF values for low-grade gliomas and radiation necrosis for both GE ($p=0.03$) and SE ($p=0.01$). (Note that in 6 cases (2 radiation necrosis, 4 tumor), an arterial input function (AIF) was not sufficient for CBF calculation (due to manual contrast injection) and are therefore not included.) Other neuroimaging techniques such as PET and MRS cannot always distinguish between tumor recurrence and radiation necrosis. Here we demonstrate that, combined GE/SE imaging can categorize lesions and therefore has the potential to optimize treatments, and influence patient care.

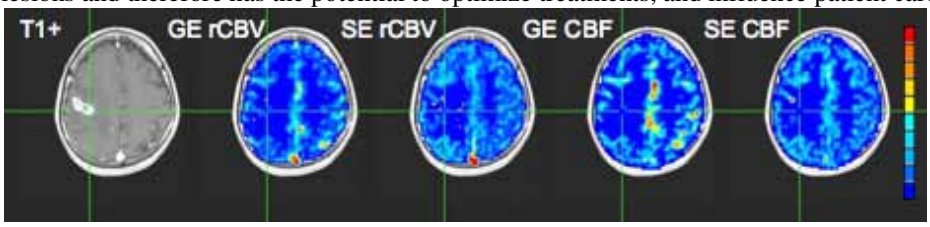

Figure 1. Radiation Necrosis Case

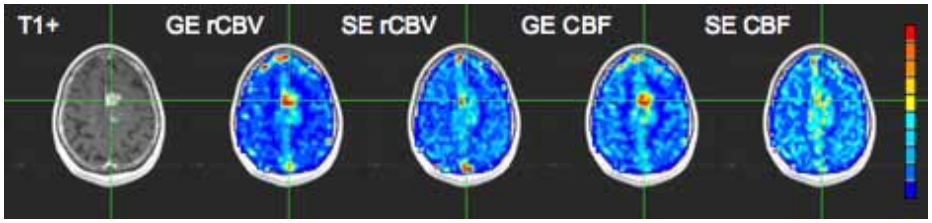

Figure 2. Low-Grade Tumor Case

References (1) Schmainda KM et al., AJNR 25:1524 (2004); (2) Ostergaard L et al., Magn Reson Med 36:715 (1996); (3) Quarles CC et al., Magn Reson Med 53:1307 (2005).

Acknowledgments

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