Differentiation between Nonenhancing Tumor in Glioblastoma and Vasogenic Edema using Diffusion-Weighted and Dynamic Susceptibility Contrast MR Imaging

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Abstract

Background and purpose: Differentiating nonenhancing glioblastoma from vasogenic edema remains a challenge in neuroimaging. This study evaluates the utility of diffusion-weighted and dynamic susceptibility contrast MR imaging, particularly ADC and relative CBV (rCBV), in distinguishing these entities.

Materials and methods: We retrospectively analyzed 111 patients diagnosed with glioblastoma with available pretreatment MRIs from January 1, 2022, to December 31, 2023, including 13 patients with 15 solid, nonenhancing glioblastoma lesions and 98 patients with perilesional nonenhancing T2-FLAIR hyperintensity surrounding enhancing glioblastomas. Their ADC and rCBV values were compared with those of 30 brain metastatic lesions age- and sex-matched to solid, nonenhancing glioblastoma lesions. Receiver operating characteristic analysis was performed to determine optimal ADC and rCBV thresholds for classification.

Results: Solid, nonenhancing glioblastomas had significantly lower mean ADC values and higher mean rCBV values compared with vasogenic edema (1.08 [SD, 0.22] × 10^{-3} versus 1.74 [SD, 0.17] × 10^{-3} mm^2/s and 2.4 [SD, 0.86] versus 0.30 [SD, 0.13], respectively; P < .001). The optimal ADC and rCBV cutoffs for differentiating solid, nonenhancing glioblastoma from vasogenic edema were 1.36 × 10^{-3} mm^2/s and 1.04, achieving excellent sensitivity (0.93-1) and specificity (1). Perilesional nonenhancing T2-FLAIR hyperintensity around enhancing glioblastomas had ADC values similar to those of vasogenic edema (1.67 [SD, 0.33] × 10^{-3} versus 1.74 [SD, 0.17] × 10^{-3} mm^2/s; P = .32) but significantly higher rCBV (0.60 [SD, 0.61] versus 0.30 [SD, 0.13]; P = .03). An rCBV cutoff value of 0.42 distinguished perilesional tumor infiltration from pure vasogenic edema with 86% specificity.

Conclusions: Diffusion- and perfusion-weighted MR imaging, particularly ADC and rCBV measurements, provide valuable biomarkers for differentiating nonenhancing glioblastoma from vasogenic edema. The identified threshold values may enhance glioblastoma characterization, improve preoperative differentiation from metastases, and support more precise, image-guided clinical management.