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Prognostic relevance of CSF and peri-tumoral edema volumes in glioblastoma

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Abstract

Background: We conducted a segmental volumetric analysis of pre-operative brain magnetic resonance images (MRIs) of glioblastoma patients to identify brain- and tumor-related features that are prognostic of survival.

Methods: Using a dataset of 210 single-institutional adult glioblastoma patients, total volumes of the following tumor- and brain-related features were quantified on pre-operative MRIs using a fully automated segmentation tool: tumor enhancement, tumor non-enhancement, tumor necrosis, peri-tumoral edema, grey matter, white matter, and cerebrospinal fluid (CSF). Their association with survival using Cox regression models, adjusting for the well-known predictors of glioblastoma survival. The findings were verified in a second dataset consisting of 96 glioblastoma patients from The Cancer Imaging Archive and The Cancer Genome Atlas (TCIA/TCGA).

Results: CSF volume and edema were independently and consistently associated with overall survival of glioblastoma patients in both datasets. Greater edema was associated with increased hazard or decreased survival [adjusted hazard ratio (aHR) with 95% confidence interval (CI): 1.34 [1.08-1.67], $p = 0.008$ (institutional dataset); and, 1.44 [1.08-1.93], $p = 0.013$ (TCIA/TCGA dataset)]. Greater CSF volume also correlated with increased hazard or decreased survival [aHR 1.27 [1.02-1.59], $p = 0.035$ (institutional dataset), and 1.42 [1.03-1.95], $p = 0.032$ (TCIA/TCGA dataset)].

Conclusions: Higher brain CSF volume and higher edema levels at diagnosis are independently associated with decreased survival in glioblastoma patients. These results highlight the importance of a broader, quantitative brain-wide radiological analyses and invite investigations to understand tumor-related causes of increased edema and possibly increased CSF volume.

Keywords: Csf; GBM; Glioblastoma; MRI; Survival.

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