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Distinguishing Tumor Cell Infiltration and Vasogenic Edema in the Peritumoral Region of Glioblastoma at the Voxel Level via Conventional MRI Sequences

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Abstract

Rationale and objectives: The peritumoral region of glioblastoma (GBM) is composed of infiltrating tumor cells and vasogenic edema, which are difficult to distinguish manually on MRI. To distinguish tumor cell infiltration and vasogenic edema in GBM peritumoral regions, it is crucial to develop a method that is precise, effective, and widely applicable.

Materials and methods: We retrieved the image characteristics of 379,730 voxels (marker of tumor infiltration) from 28 non-enhanced gliomas and 365,262 voxels (marker of edema) from the peritumoral edema region of 14 meningiomas on conventional MRI sequences (T1-weighted image, the contrast-enhancing T1-weighted image, the T2-weighted image, the T2-fluid attenuated inversion recovery image, and the apparent diffusion coefficient map). Using the SVM classifier, a model for predicting tumor cell infiltration and vasogenic edema at the voxel level was developed. The accuracy of the model's predictions was then evaluated using 15 GBM patients who underwent stereotactic biopsies.

Results: The area under the curve (AUC), accuracy, sensitivity, and specificity of the prediction model were 0.93, 0.84, 0.83, and 0.85 in the training set, and 0.90, 0.82, 0.83, and 0.83 in the test set (704,992 voxels), respectively. The pathology verification of 28 biopsy points with an accuracy of 0.79.

Conclusion: At the voxel level, it seems possible to forecast tumor cell infiltration and vasogenic edema in the peritumoral region of GBM based on conventional MRI sequences.

Keywords: Conventional MRI; Glioblastoma; Machine learning; Peritumoral region; Voxel level.