

Glioma Imaging Predicts Underlying Genetic Mutations: A Multi-Center Study

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Background: Gliomas are the most common malignant primary brain tumor. Genomic characterization is necessary for diagnosis and treatment decisions, for which the brain is biopsied and can lead to delays in care, morbidity, and mortality. Here, we demonstrate a relationship between the appearance of an adult glioma on MRI and its genetic profile.

Methods: Pre-operative MRIs of histopathologically-proven gliomas from three health systems were obtained. Segmentation masks of the enhancing tumor, non-enhancing/necrotic tumor, and surrounding FLAIR abnormality were manually extracted. All tumors were evaluated for IDH mutations and 1p/19q codeletion; all grade III and IV tumors were tested for MGMT methylation. The segmentation masks were processed to create topological and geometric features describing the tumor's 3D shape. These features, without other clinical variables, were used in a custom machine learning pipeline to predict the presence of IDH mutations, 1p/19q codeletion, and MGMT methylation.

Results: On the blinded test-subset, the machine learning model, using only features describing the tumor's shape, resulted an AUROC of 0.902 (95% CI: 0.875-0.929), specificity of 90.3% (83.9%-96.6%), and sensitivity of 75.7% (68.0%-83.3%) for IDH mutation. For 1p/19q codeletion, we found an AUROC of 0.949 (0.908-0.990), specificity of 94.5% (84.3%-100%), and sensitivity of 86.6% (79.6%-93.6%). For MGMT methylation, the performance was poor with an AUROC of 0.445 (0.385-0.504).

Conclusions: The three-dimensional shape of a glioma may be used to predict the presence of some key underlying genetic mutations. Additional research is needed to validate these findings, improve the model's fidelity, and evaluate the potential role for imaging to replace tissue biopsy, thus sparing patient's the risk of brain biopsies and accelerating their oncological care.

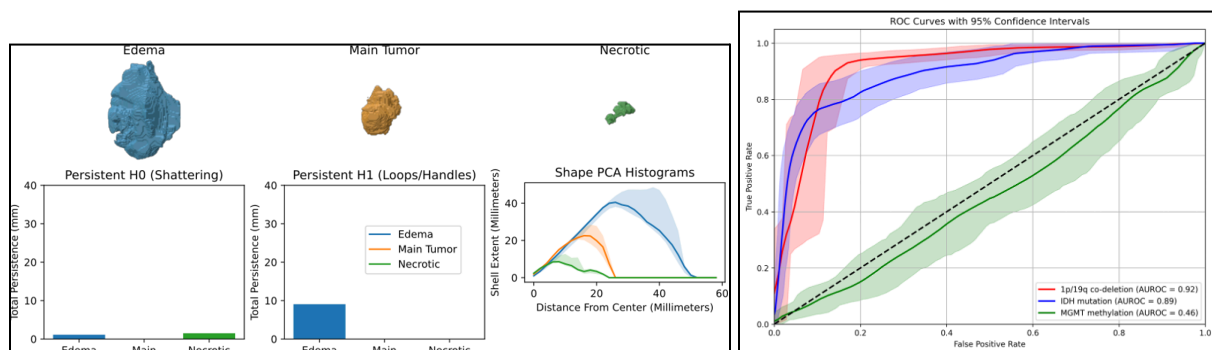


Figure 1 (Left). Segmentation masks of the gliomas and example topological features extracted.

Figure 2 (Right). Receiver operating curve of the machine learning model on the test set.