Abstract:

Modern standard of care for patients diagnosed with glioma is dependent on grading by microscopic features obtained from biopsy. The purpose of this work was to evaluate the accuracy of a voxel-wise, multiparametric MRI radiomic method to predict glioma grade and microscopic features. We retrospectively evaluated five pre-intervention MRI sequences (T1, T2, FLAIR, ADC, T1+) for seventeen patients histologically diagnosed with glioma. Pre-intervention MRI sequences were registered to T1-weighted gadolinium contrast-enhanced data using a 12 degree-of-freedom affine model. Clinical experts provided annotations for up to nine classes: five disease and four normal states. A voxel-wise feature vector constructed from annotations tested and trained a k-nearest-neighbor (k-NN) model to predict voxels annotation class. A combination of predicted disease compositions (PDC) and age at diagnosis were statistically tested to predict prognosis and differentiate clinical factors. Student’s t-test ($\alpha=0.05$) investigated population differences for demographic and clinical factors. Multiple regression ($\alpha=0.05$) tested the relationship of progression-free and overall survival (PFS and OS, respectively) to PDC and age at diagnosis. Canonical discriminant analysis with stepwise Wilk’s lambda ($\alpha=0.1$) tested whether PDC and age at diagnosis could differentiate clinical, genetic, and microscopic factors. Tumor grades differed in patient age ($p=0.029$), PFS ($p=0.013$), and OS ($p=0.016$). PDC and age at diagnosis predicted OS ($p=0.007$) and discerned tumor grade ($p=0.035$), in addition to mutations in the genes CDKN2A ($p=0.021$), CDKN2B ($p=0.001$), NF1 ($p=0.055$), TP53BP1 ($p=0.046$), and IDH1 ($p=0.048$). The PDC discerned glioma grade and clinically relevant microscopic characteristics. This voxel-wise, multiparametric radiomic strategy holds potential as a non-invasive decision-making aid for clinicians managing patients with glioma.