GB-NeuroAnalysis AI: Early Diagnosis of Glioblastoma Multiforme in MRI Images Through a Novel End-to-End Deep Learning Pipeline

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Glioblastoma multiforme (GBM) is a highly invasive malignant brain tumor with a low patient survival rate. Tumor cells multiply quickly into healthy brain tissue, making it difficult to remove the spreading mass. During diagnosis, a radiologist must localize the tumor by segmenting it on magnetic resonance imaging (MRI), which may be time-consuming and prone to human error. The rise of deep learning may bridge the gap between manual segmentation by a radiologist and more objective tumor segmentation by automating the mainstream process for timely glioblastoma-specific diagnosis. This study aimed to create a deep learning pipeline, GB-NeuroAnalysis AI, that processes pre-operative MRI images of GBM and accurately segments the tumor in three dimensions for diagnostic visual analysis. The pipeline used the UPenn-GBM dataset with MRI input modalities and manual segmentations for each patient to train and test the model. The workflow contained a skull stripping algorithm and multi-modal co-registration to assist a radiologist's workload in real-time before automated segmentation, making the pipeline end-to-end. The pipeline then used a 3D U-Net architecture to segment the tumors. The segmentation model achieved an accuracy of 0.96 on the Jaccard index and a dice score of 0.82 on the whole tumor, similar to the dice score accuracy of a radiologist. The model seeks to improve diagnosis and prognosis in the future by optimizing the model's ability to identify segmentation in a longitudinal timeframe. Not only does GB-NeuroAnalysis AI introduce a high-performance end-to-end pipeline that may be integrated into a surgical workflow in diverse clinical settings, but it also serves as a potential diagnostic tool in underdeveloped countries with limited neuro-radiology resources.