

A Multimodal Deep Learning Architecture for Distant Recurrence Prediction in NSCLC Patients Treated with Stereotactic Body Radiation Therapy

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Abstract

Purpose: Stereotactic Body Radiation Therapy (SBRT) is a highly precise and advanced non-invasive treatment procedure for early-stage non-small cell lung cancer (NSCLC) patients. Despite its advancement, the mortality rate with distant recurrence can be observed to be more than 30% after SBRT treatment. In this regard, the aim of this study is to design a Deep Neural Network (DNN) architecture-based distant recurrence prediction model for NSCLC patients, while assisting clinicians in making prompt decisions in treatment planning.

Method: This study incorporates 150 early-stage NSCLC patients' data who underwent SBRT treatment at our Institute between 2013 to 2018. The clinical stage for this dataset was limited to T1N0 or T2N0. All patients underwent the SBRT dose of 50 Gy to 60 Gy in 3 to 5 fractions. The designed DNN-based prediction model utilized three different types of input features, planning CT images with PTV contours, patient-specific clinical features, and dosiomic features during SBRT treatment.

Results: The designed DNN model with the integration of heterogeneous features set achieved the performance as AUC of 0.76(0.04), sensitivity of 0.65(0.10), and specificity of 0.87(0.07). Moreover, conventional pre-trained VGG16 and ResNet50 models were compared with our proposed methodology to investigate the effectiveness of the designed model. The proposed multichannel DNN-based architecture demonstrated enhanced performance, achieving a 12% to 21% increase in AUC compared to other pre-trained models.

Conclusion: This study emphasizes the impact of combining deep features from planning CT images with patient-specific clinical, and dose-distribution data on developing a distant recurrence prediction model for early-stage NSCLC patients after two years of SBRT. However, to improve generalizability and strengthen robustness, incorporating multi-institute data with a larger cohort of patients is essential.