Multi-modal Prediction of Laryngeal Cancer Recurrence for Identifying Adjuvant Radiotherapy Benefit

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Purpose: Laryngeal squamous cell carcinoma (LSCC) causes over 100,000 deaths annually worldwide. While adjuvant radiotherapy after surgical resection can reduce the risk of recurrence and improve disease-free survival (DFS), accurate stratification of recurrence risk for optimized treatment planning remains challenging. This study aimed to develop a multi-modal deep learning-based model to predict DFS outcomes and identify patients who may benefit from adjuvant radiotherapy. Methods: Primary tumor whole slide pathology images (WSI) and clinicopathological features were collected from 177 LSCC patients who underwent curative local surgery from the HANCOCK dataset. A multiple-instance learning algorithm analyzed histopathological features from WSI to generate a risk score, which was combined with clinical variables in a Cox regression model to predict DFS. Propensity score matching with stratified Cox regression evaluated radiotherapy benefit across model-defined risk groups. Results: The multi-modal model achieved a C-index of 0.78 (95% CI: 0.64–0.90) and average AUC of 0.86 (95% CI: 0.71–0.96) over four years on the test set (n=36), significantly stratifying patients into high and low-risk groups (p=0.002). Low-risk patients showed no benefit (p=0.085), while high-risk patients demonstrated significant benefit from adjuvant radiotherapy in DFS (p=0.001; interaction p=0.001). Conclusions: This study demonstrates a multi-modal deep learning approach for predicting laryngeal cancer recurrence and identifying patients who would benefit from adjuvant radiotherapy, potentially enabling more personalized treatment recommendations.

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