

MACHINE LEARNING BASED ON CT RADIOMIC FEATURES PREDICTS RESIDUAL TUMOR IN HEAD AND NECK CANCER PATIENTS TREATED WITH CHEMORADIOTHERAPY

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ABSTRACT

Surveillance imaging of HNSCC in patients treated with chemoradiotherapy suffers from difficulty in differentiating residual disease from radiation changes and inflammation. Thus, this study assessed ML models based on RadFs extracted from standard CT images pre- and post-chemoradiation to predict HNSCC treatment response. A retrospective analysis of HNSCC patients treated with definitive chemoradiotherapy at our institution between 2006 and 2015 was performed. Thirty-six patients with residual disease on CT scans of the soft tissue of the neck at a two-month interval-either in the primary site, nodal stations, or both-were enrolled. GTV contours from the treatment planning CT (CT1), post-treatment CT (CT2), and CT portion of the PET/CT (CT3) of the neck were exported to MatLab®, where 2D and 3D RadFs were extracted using different methods. Finally, ML models were used to identify the RadFs that predict changes and progression in HNSCC patients treated with chemoradiotherapy. SVM models using 2D RadFs, extracted from CT2, were associated with residual disease on PET/CT exams (AUC = 0.702). 2D RadFs extracted from PET/CT had moderate predictive ability to predict positive pathology for residual tumor (AUC = 0.667). NN and RF models of 3D RadFs extracted from CT2 and PET/CT had good and moderate predictive ability to predict positive pathology for residual tumor (AUC = 0.720 and 0.678, respectively). ML models using 2D and 3D RadFs derived from pre- and post-treatment CT data show promise for predicting residual tumor from radiation changes and inflammation in a small group of HNSCC cancer patients treated with chemoradiotherapy.

Keywords: brain computed tomography, head and neck cancer, squamous cell carcinoma, chemoradiotherapy, radiomics, big data, artificial intelligence in medicine, machine learning.

Abbreviations: HNSCC, squamous cell carcinoma of the head and neck; ML, machine learning; RadFs, radiomic features; GTV, gross tumor volume; CT, computed tomography; PET, positron emission tomography; SVM, support vector machine; NN, neural network ; RF, random forest; AUC, area under the curve.

INTRODUCTION

Squamous cell carcinoma of the head and neck (HNSCC) is the sixth most common cancer and accounts for approximately 4% of all cancers in the United States [1]. According to the American Cancer Society, an estimated 65,000 people (48,000 men and 17,000 women) develop HNSCC each year, and at least 20% of these patients could die [1]. The average age of patients diagnosed with HNSCC is 62 years old, usually with a long history of smoking, heavy alcohol use, or infection with high-risk types of human papillomavirus (HPV) and Epstein Barr Virus (EBV) [2, 3].