

Pre-treatment prediction of extranodal extension in head and neck cancer using machine learning and radiomics



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BACKGROUND

- Extranodal extension (ENE) portends poor prognosis in oral cavity squamous cell carcinoma (OCSCC) and is an indication for post-operative chemoradiation (CRT)
- Identifying ENE pre-operatively can help to avoid triple modality therapy in patients who will require post-operative CRT
- The accuracy of clinician identification of ENE on pre-operative imaging is low, and recent work using machine learning in combination with high-throughput imaging analysis (radiomics) has shown promise for aiding ENE diagnosis

OBJECTIVE

- We aim to design an algorithm to improve pretreatment identification of ENE in patients with head and neck cancer

METHODS

- Eighteen patients** with primary oral cavity cancer were retrospectively evaluated
- A **total of 44 metastatic lymph nodes** were identified on contrast-enhanced computed tomography (CECT) scans
- All included lymph nodes were contoured by a trained head and neck radiologist who was blinded to the pathologic nodal stage
- Pathology reports were used to link ground-truth ENE status** to each CECT contour
- A total of one hundred-fifty-six tumoral (original contour), peritumoral (2 mm perimeter dilation), and interior (2 mm perimeter erosion) radiomics features were extracted, including global, shape, and texture-based histogram metrics

RESULTS

Table 1 - Patient Demographics		n=18 (%)
Age (yrs)		55
Sex	Male	8 (44)
	Female	10 (56)
T Stage	T1	2 (11)
	T2	10 (56)
	T3	2 (11)
	T4	4 (22)
N Stage	N0	1 (5.5)
	N1	9 (50)
	N2	8 (44)
Primary Site	Oral Tongue	12 (67)
	Buccal Mucosa	2 (11)
	Retromolar Trigone (RMT)	2 (11)
	Alveolus	1 (5.5)
	Floor of Mouth (FOM)	1 (5.5)

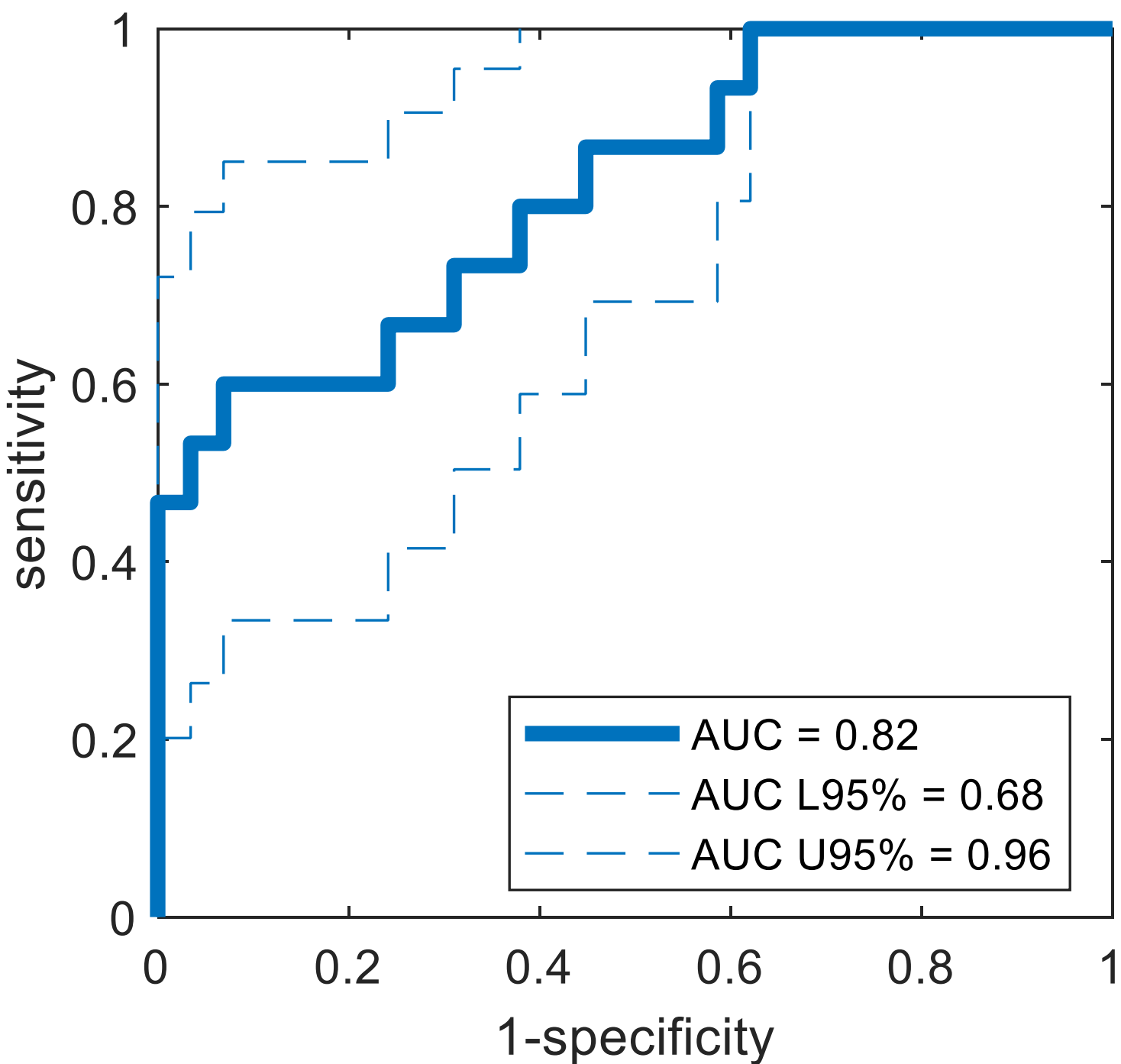
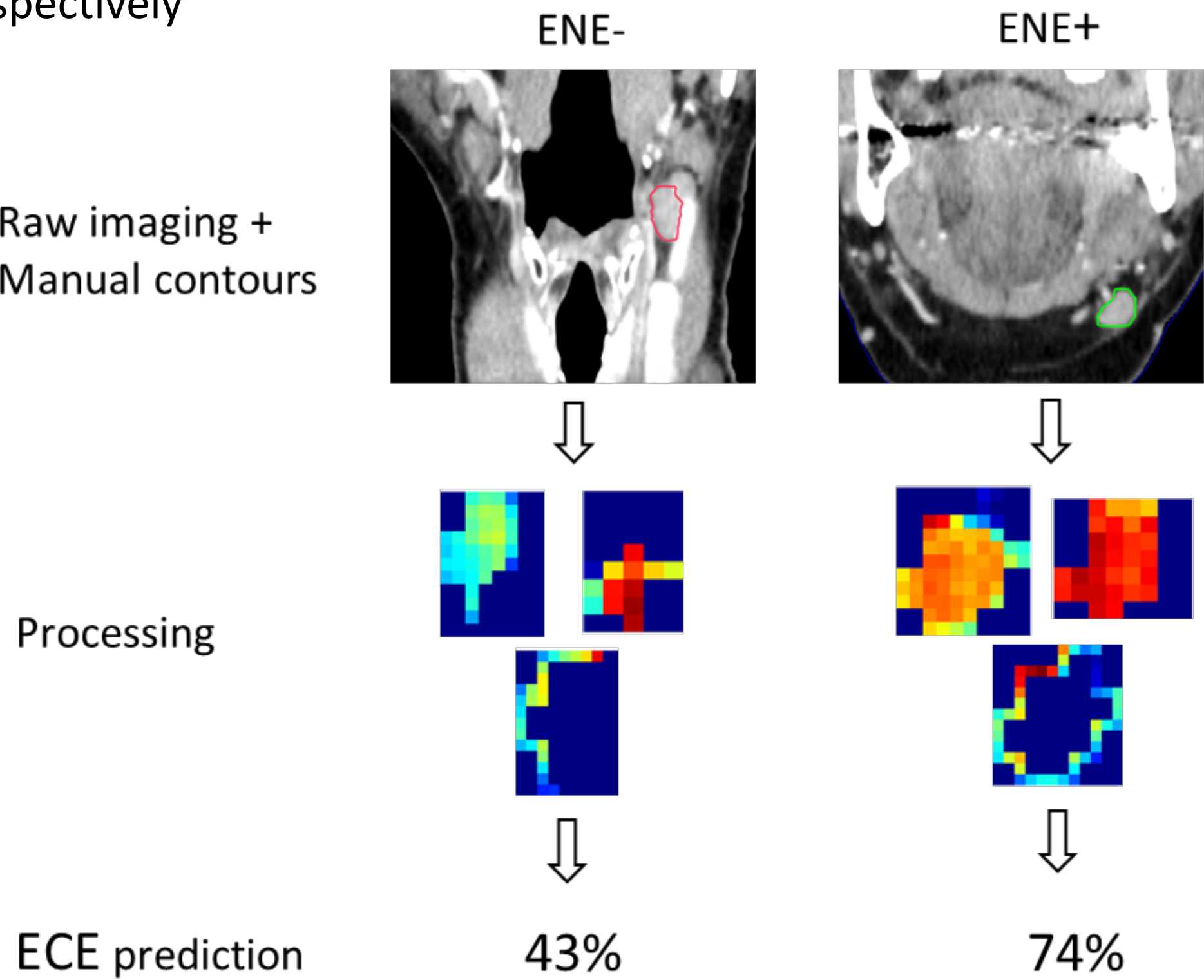
Univariate analysis: 18 features with $p < 0.05$, 14 were “periphery” features (78%)

- Peripheral global kurtosis** was the only variable to reach statistical significance with false discovery correction
- AUC of this single feature reached **0.763 (95%CI: 0.60-0.93)**

Multivariate analysis: LASSO logistic regression 5-fold cross validation conserved 4 non-zero coefficients:

- Volume, Eroded neighborhood grey-tone difference matrix (NGTDM) complexity, peripheral global kurtosis, and peripheral GLRLM_LRHGE. **AUC 0.82 (95% CI: 0.68-0.96)**

Figure 1: Imaging processing. Top pane shows nodal contouring and lower panel demonstrates full contour, eroded, and peripheral features respectively



STATISTICS

- Due to high false discovery rates associated with high correlation with lesion volume (global feature), any feature with absolute Spearman correlation > 0.5 with volume was eliminated *a priori*, leaving of total of 63 features for further statistical consideration
- Univariate analysis using a two sample Welch test with a false discovery rate controlled using Bonferroni correction as well as multivariate analysis using LASSO regression with 10-fold cross validation were performed for preliminary model building
- Model predictive performance was compared to the reference model (radiologist interpretation) using the area under the receiver operating characteristic curve (AUC)

CONCLUSION AND SIGNIFICANCE

- Radiomics may complement existing methods for predicting ENE in HNSCC. Peritumoral imaging characteristics seem to play a significant role in the current radiomics model, of which validation is ongoing.

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