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Article

MRI in Oral Tongue Squamous Cell Carcinoma: A Radiomic Approach in the Local Recurrence Evaluation

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Abstract: (1) Background: Oral tongue squamous cell carcinoma (OTSCC) is a prevalent malignancy with high loco-regional recurrence. Advanced imaging biomarkers are critical for stratifying patients at a high risk of recurrence. This study aimed to develop MRI-based radiomic models to predict loco-regional recurrence in OTSCC patients undergoing surgery. (2) Methods: We retrospectively selected 92 patients with OTSCC who underwent MRI, followed by surgery and cervical lymphadenectomy. A total of 31 patients suffered from a loco-regional recurrence. Radiomic features were extracted from preoperative post-contrast high-resolution MRI and integrated with clinical and pathological data to develop predictive models, including radiomic-only and combined radiomic–clinical approaches, trained and validated with stratified data splitting. (3) Results: Textural features, such as those derived from the Gray-Level Size-Zone Matrix, Gray-Level Dependence Matrix, and Gray-Level Run-Length Matrix, showed significant associations with recurrence. The radiomic-only model achieved an accuracy of 0.79 (95% confidence interval: 0.69, 0.87) and 0.74 (95% CI: 0.54, 0.89) in the training and validation set, respectively. Combined radiomic and clinical models, incorporating features like the pathological depth of invasion and lymph node status, provided comparable diagnostic performances. (4) Conclusions: MRI-based radiomic models demonstrated the potential for predicting loco-regional recurrence, highlighting their increasingly important role in advancing precision oncology for OTSCC.

Keywords: oral tongue squamous cell carcinoma (OTSCC); radiomics; machine learning (ML); MRI-based models; loco-regional recurrence; imaging biomarkers; precision oncology

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1. Introduction

Oral tongue squamous cell carcinoma (OTSCC) is the most common malignancy of the oral cavity (OC), accounting for about half of all instances of head and neck squamous cell carcinoma (SCC) [1]. Surgery is the primary treatment, followed by adjuvant radiotherapy +/− chemotherapy in the presence of negative pathological prognostic factors, such as a residual tumor, lymphovascular infiltration, or lymph node metastases with extracapsular extension (ENE) [2–4]. Immunotherapy is reserved for cases of recurrence (local or distant),

refractoriness to platinum-based treatment, and tumor expression of a PD-L1 combined positive score > 1 [5]. Despite the use of combined therapies, the 5-year survival rate remains unsatisfactory (50–60%), and the frequency of loco-regional recurrence is high (approximately 40%) [6–11]. Among the most significant negative prognostic factors, the presence of lymph node metastases with ENE, positive resection margins, a greater depth of invasion (DOI) [8,10,12–15], and quantitative lymph node burden [16] have been demonstrated to be relevant negative prognostic factors. Currently, magnetic resonance imaging (MRI) is used for the loco-regional staging of tongue tumors [2], thanks to the high contrast resolution, which permits the obtainment of an optimal evaluation of the submucosal spread; for this reason, MRI represents a guide to surgical planning. Computed tomography (CT) and positron emission tomography (PET)–CT are techniques that can be used in the staging of oral tongue cancer. PET/CT represents a valuable alternative or complementary technique to MRI because of its high negative predictive value in the lymph node evaluation and proven benefits in post-therapy assessment [17,18]. At the same time, CT is useful in evaluating mandibular involvement (cortical infiltration) and in patients with contraindications to MRI [19].

Additional biomarkers are needed for imaging evaluation to stratify the patients and obtain personalized therapy. Regional recurrence is the most common cause of failure for OTSCC [20,21]; for this reason, identifying patients at risk of recurrence before primary surgery is very important to guide the treatment plan. Histopathological factors, through the biopsy before the surgery, are used for OTSCC diagnosis and prognosis. Still, the limitation of biopsy is that it may not capture the heterogeneity of the tumor due to a sampling bias. An emerging field of precision medicine is radiomics [22], which enables the extraction of quantitative features, such as texture, shape, and intensity, from radiological images. This large amount of quantitative data can be incorporated into machine learning (ML) models to better describe the tumor phenotype [23]. Radiomics provides a non-invasive, cost-effective, and reproducible approach to analyzing tumor heterogeneity, and can potentially improve the quality of tumor treatment within the framework of precision medicine and personalized care. Additionally, it has demonstrated promising prognostic value by quantifying the imaging features related to the entire tumor heterogeneity, which has been linked to adverse outcomes such as recurrence and poor survival [24,25].

This study aims to develop an MRI-based radiomic model to predict loco-regional recurrence from a retrospective setting in patients affected by OTSCC who underwent surgery.

2. Materials and Methods

2.1. Patient Population

We performed a retrospective radiomic analysis on the preoperative MRI of patients with OTSCC surgically treated at the Regina Elena National Cancer Institute.

This single-institution retrospective study was approved by the institutional ethics committee (RS1834/23). The requirement for obtaining written informed consent was waived due to the retrospective nature of this study.

Inclusion criteria were the diagnosis of OTSCC, surgery performed between 2014 and 2023, preoperative MRI (within 2 weeks before surgery), the presence of a tumor that could be measured on MRI, a pathological depth of invasion (pDOI) measurement in the histopathological report, and clinical information about the follow-up. The exclusion criteria were preoperative chemo-radiotherapy, classification as T4a for the mandibular infiltration, poor MRI quality because of motion artifacts and/or image distortion due to dental implants, and inadequate follow-up information (irretrievable medical information data).

All of the patients were staged and restaged according to the criteria outlined in the 8th edition of the AJCC TNM classification, which includes DOI as a crucial parameter