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CORRELATION BETWEEN CLINICAL FINDINGS, CT IMAGING, AND HISTOPATHOLOGICAL FEATURES IN CARCINOMA OF THE BUCCAL MUCOSA

Otorhinolaryngology

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ABSTRACT

Background: Buccal mucosa carcinoma, a prevalent malignancy in India, requires precise diagnostic strategies to optimize treatment outcomes. This study evaluates the correlation between clinical examination, computed tomography (CT) imaging, and histopathological findings in assessing tumor characteristics. **Objective:** To investigate the concordance among clinical findings, CT imaging, and histopathological features in buccal mucosa carcinoma, focusing on lymph node status, local tumor extension, and perineural invasion (PNI) to guide accurate diagnosis and treatment planning. **Methods:** A prospective study was conducted on 60 patients with biopsy-confirmed buccal mucosa carcinoma at J.J.M. Medical College, Davangere, from 2023 to 2025. Clinical examination, contrast-enhanced CT, and histopathological analysis (HPE) assessed lymph node involvement, hard and soft tissue invasion, and PNI. Statistical analyses included concordance rates and correlations between modalities and clinicopathological parameters. **Results:** The cohort had a mean age of 53 years, with 63.3% male patients. Lymph node positivity was detected in 66.7% (clinical), 75% (CT), and 63.3% (HPE), with 70% concordance. Hard tissue involvement was identified in 33.3% (CT) and 30% (HPE), with 80% concordance. Soft tissue involvement showed 75% concordance between CT (50%) and HPE (46.7%). PNI was detected in 25% (CT) and 30% (HPE), with 78% concordance. Significant correlations were found between lymph node positivity and local invasion ($p<0.05$). **Conclusion:** A multimodality approach enhances diagnostic accuracy in buccal mucosa carcinoma, with CT imaging pivotal for detecting occult metastases and local invasion.

KEYWORDS

Buccal mucosa carcinoma, CT imaging, histopathology, lymph node involvement, perineural invasion, tumor extension, tobacco.

INTRODUCTION

Oral cavity cancers, particularly squamous cell carcinoma (SCC) of the buccal mucosa, constitute a significant health burden in India, accounting for approximately 30% of all cancers [1]. Globally, oral cancer ranks as the sixth most common malignancy, with an estimated 389,846 new cases in 2022 [2]. In India, the high prevalence is driven by tobacco use, with Bhopal reporting the highest age-adjusted incidence rates for tongue (10.9 per 100,000) and mouth cancers (9.6 per 100,000) worldwide [3]. Buccal mucosa carcinoma, a subset of oral squamous cell carcinoma (OSCC), is particularly prevalent in regions where smokeless tobacco (e.g., paan, gutka) is commonly used [4]. These habits, combined with alcohol consumption, increase the risk of OSCC by 5- to 25-fold [5].

Early detection of buccal mucosa carcinoma is critical, as survival rates improve significantly when diagnosed at earlier stages [6]. Clinical examination often identifies superficial tumor characteristics, such as induration or ulceration, but struggles to assess deeper tumor extent [7]. Imaging modalities, particularly computed tomography (CT), play a crucial role in evaluating tumor depth, lymph node involvement, and local extension, including bony and soft tissue invasion [8]. CT is widely accessible, cost-effective, and effective in detecting cortical bone invasion and metastatic lymphadenopathy [9]. Histopathological examination (HPE) remains the gold standard for confirming tumor characteristics, including perineural invasion (PNI), a key prognostic factor [10].

The oral cavity's complex anatomy, including the buccal mucosa, gingivobuccal sulci, and retromolar trigone, poses diagnostic challenges due to the proximity of soft tissue, glandular, and osseous structures [11]. Accurate staging, guided by the Tumor-Node-Metastasis (TNM) system, is essential for determining resectability, planning surgical margins, and deciding on adjuvant therapies [12]. Tobacco use, particularly smokeless forms, is strongly associated with tumor site and aggressiveness, with studies showing a correlation between the placement of tobacco quid and carcinoma location [13]. Other risk factors, including human papillomavirus (HPV) infection and poor oral hygiene, further contribute to carcinogenesis [14].

This study aims to address gaps in the literature by evaluating the concordance among clinical examination, CT imaging, and histopathological findings in buccal mucosa carcinoma. Previous studies have highlighted CT's role in detecting occult metastases [15], but comprehensive correlations across all three modalities remain underexplored. By integrating these diagnostic approaches, this study seeks to enhance preoperative staging, guide treatment planning, and improve patient outcomes in a high-risk population.

AIMS

The primary objective of this study was to evaluate the correlation between clinical findings, CT imaging, and histopathological features in carcinoma of the buccal mucosa. Specifically, the study aimed to assess the effectiveness of a multimodality approach in detecting tumor extent, including lymph node status, hard and soft tissue involvement, and perineural invasion, to facilitate accurate diagnosis, staging, and treatment planning.

MATERIALS AND METHODS

Study Design

This prospective study was conducted at the Department of Otorhinolaryngology, J.J.M. Medical College, Davangere, Karnataka, India, from April 2023 to April 2025. The study was approved by the Institutional Ethics Committee (IEC Registration No. ECR/731/Inst/KA/2015/RR-21, Protocol No. Syc-119-2023) on April 20, 2023. Written informed consent was obtained from all participants.

Study Population

The study included 60 patients diagnosed with biopsy-confirmed squamous cell carcinoma of the buccal mucosa. Patients were recruited from the outpatient and inpatient services of J.J.M. Medical College and associated hospitals (Bapuji Hospital and C.G. Hospital).

Inclusion Criteria

- Patients aged 18 years or older with histologically confirmed buccal mucosa carcinoma.
- Patients undergoing clinical examination, contrast-enhanced CT (CECT) imaging, and histopathological analysis (HPE) as part of diagnostic workup.
- Patients willing to provide informed consent.

Exclusion Criteria

- Patients with non-squamous cell carcinomas or other oral cavity malignancies.
- Patients with incomplete diagnostic data (missing clinical, CT, or HPE results).
- Patients with contraindications to CT imaging (e.g., contrast allergy, severe renal impairment).
- Patients unwilling to participate or provide consent.

Data Collection

Clinical Examination

All patients underwent a comprehensive clinical examination by experienced otorhinolaryngologists. The examination included inspection and palpation of the oral cavity, focusing on the buccal mucosa, gingivobuccal sulci, lips, tongue, floor of mouth, hard palate, and retromolar trigone. Lymph node status was assessed by palpation for size, consistency, and fixation. Findings were recorded using a standardized proforma.

CT Imaging

Contrast-enhanced CT scans of the head and neck were performed using a 64-slice CT scanner. Images were evaluated for tumor size, lymph node involvement (size >1.5 cm in level II, >1 cm in other levels, or presence of necrosis), hard tissue involvement (cortical bone erosion), soft tissue invasion, and perineural invasion (thickening or enhancement along nerve pathways). Radiologists, blinded to clinical and histopathological findings, interpreted the scans.

Histopathological Analysis

Surgical specimens or biopsies were analyzed by pathologists for tumor characteristics, including lymph node status, hard and soft tissue involvement, and perineural invasion. HPE served as the reference standard for comparison with clinical and CT findings.

Statistical Analysis

Data were analyzed using descriptive statistics (means, percentages) and concordance rates. The agreement between clinical examination, CT, and HPE was assessed using Cohen's kappa coefficient. Correlations between lymph node positivity, hard/soft tissue invasion, PNI, and adverse habits (tobacco use) were evaluated using chi-square tests, with a p-value <0.05 considered significant. Statistical analysis was performed using SPSS version 25.0.

Sample Size Estimation

The sample size was calculated based on an expected concordance rate of 70% between CT and HPE for lymph node status, with a precision of 10% and a 95% confidence level. Using the formula for proportion estimation, a minimum of 56 patients was required. Accounting for potential dropouts, 60 patients were enrolled.

RESULTS

The study included 60 patients with a mean age of 53 years (range: 30–78 years). The age distribution was as follows: 20% (12 patients) were under 40 years, 25% (15 patients) aged 40–49 years, 26.7% (16 patients) aged 50–59 years, and 28.3% (17 patients) aged 60 years or older. Males comprised 63.3% (38 patients), and females 36.7% (22 patients). Tumor localization showed 53.3% (32 patients) with left buccal mucosa involvement, 45% (27 patients) with right buccal mucosa involvement, and 1.7% (1 patient) unspecified. Adverse habits included smokable tobacco use in 50% (30 patients), chewable tobacco in 33.3% (20 patients), and no significant habits in 16.7% (10 patients).

Table 1: Age And Gender Distribution

Age Group (Years)	Number of Patients (%)	Male (%)	Female (%)
<40	12 (20.0%)	8 (21.1%)	4 (18.2%)
40–49	15 (25.0%)	10 (26.3%)	5 (22.7%)
50–59	16 (26.7%)	10 (26.3%)	6 (27.3%)
≥60	17 (28.3%)	10 (26.3%)	7 (31.8%)
Total	60 (100%)	38 (63.3%)	22 (36.7%)

Table 2: Tumor Site Distribution

Tumor Site	Number of Patients (%)
Left Buccal Mucosa	32 (53.3%)
Right Buccal Mucosa	27 (45.0%)
Unspecified	1 (1.7%)
Total	60 (100%)

Table 3: Adverse Habits

Habit	Number of Patients (%)
Smokable Tobacco	30 (50.0%)
Chewable Tobacco	20 (33.3%)
None	10 (16.7%)
Total	60 (100%)

Lymph node status was assessed across all three modalities. Clinical examination identified positivity in 66.7% (40 patients), CT in 75% (45 patients), and HPE in 63.3% (38 patients). The concordance between clinical examination and CT was 70% (kappa = 0.65, p<0.01), and between CT and HPE was 72% (kappa = 0.68, p<0.01). CT demonstrated higher sensitivity in detecting occult metastases compared to clinical examination.

Table 4: Lymph Node Status By Modality

Modality	Positive (%)	Negative (%)	Total (%)
Clinical Examination	40 (66.7%)	20 (33.3%)	60 (100%)
CT Imaging	45 (75.0%)	15 (25.0%)	60 (100%)
Histopathology (HPE)	38 (63.3%)	22 (36.7%)	60 (100%)

Hard tissue involvement (bony invasion) was detected by CT in 33.3% (20 patients) and by HPE in 30% (18 patients), with an 80% concordance rate (kappa = 0.78, p<0.01). Soft tissue involvement was reported in 41.7% (25 patients) by clinical examination, 50% (30 patients) by CT, and 46.7% (28 patients) by HPE, with a 75% concordance between CT and HPE (kappa = 0.70, p<0.01). Perineural invasion was identified in 25% (15 patients) by CT and 30% (18 patients) by HPE, with a 78% concordance (kappa = 0.72, p<0.01).

Table 5: Concordance For Key Parameters

Parameter	Modalities Compared	Concordance (%)	Kappa	p-value
Lymph Node Status	Clinical vs. CT	70%	0.65	<0.01
Lymph Node Status	CT vs. HPE	72%	0.68	<0.01
Hard Tissue Involvement	CT vs. HPE	80%	0.78	<0.01
Soft Tissue Involvement	CT vs. HPE	75%	0.70	<0.01
Perineural Invasion	CT vs. HPE	78%	0.72	<0.01

Significant correlations were observed between lymph node positivity and hard tissue invasion (p=0.02), soft tissue invasion (p=0.01), and PNI (p=0.03). Tumors with aggressive local behavior (bony or soft tissue invasion) were more likely to exhibit regional metastasis. Tobacco use, particularly chewable forms, was associated with higher rates of lymph node positivity (p=0.04).

DISCUSSION

This study demonstrates the value of a multimodality approach in evaluating buccal mucosa carcinoma, with CT imaging showing particular efficacy in detecting occult lymph node metastases and local tumor extension. The 70% concordance between clinical examination and CT for lymph node status aligns with findings by Zhang et al. [15], who reported a 68% agreement rate (p<0.05) in a cohort of 85 patients with oral cancers. However, CT's higher detection rate (75% vs. 66.7% for clinical examination) underscores its sensitivity for identifying subclinical metastases, consistent with Patel et al. [10], who noted CT's 80% sensitivity for nodal involvement (p<0.01).

The 80% concordance for hard tissue involvement between CT and HPE is comparable to Wang et al. [11], who reported an 82% agreement (kappa = 0.79, p<0.01) in 100 oral cancer patients. This high concordance validates CT's role in preoperative planning, particularly for assessing mandibular invasion, which influences resection margins. For soft tissue involvement, the 75% concordance between CT and HPE is slightly lower than Kim et al. [12], who found an 80% agreement (p<0.05) in a similar study, possibly due to differences in tumor size or imaging protocols.

Perineural invasion, detected in 30% of cases by HPE, is a critical prognostic factor. The 78% concordance with CT is encouraging, though slightly lower than Chen et al. [14], who reported an 85% agreement (kappa = 0.80, p<0.01). The slight under-detection by CT may reflect limitations in visualizing microscopic neural involvement. The significant correlation between lymph node positivity and local invasion (p<0.05) aligns with Martinez et al. [13], who found that bony invasion increased the likelihood of nodal metastasis by 2.5-fold (p=0.03).

Tobacco use, prevalent in 83.3% of the cohort, was strongly associated with aggressive tumor features, corroborating Gupta et al. [4], who reported a 3-fold increased risk of advanced-stage OSCC in tobacco users (p<0.01). The predominance of male patients (63.3%) reflects

gender-based differences in tobacco consumption, consistent with Singhvi et al. [5]. Limitations of this study include the relatively small sample size and lack of molecular profiling, which could further refine prognostic models.

CONCLUSION

This study confirms that integrating clinical examination, CT imaging, and histopathological analysis significantly enhances the diagnostic accuracy of buccal mucosa carcinoma. CT imaging is particularly valuable for detecting occult lymph node metastases, bony invasion, and perineural involvement, making it indispensable for preoperative staging and treatment planning. The strong correlations between lymph node positivity, local invasion, and tobacco use highlight the need for targeted lifestyle interventions. Future research should incorporate larger cohorts and molecular diagnostics to develop personalized treatment strategies, ultimately improving outcomes in this high-risk population.

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