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Original Article

Radiology Section

Role of Contrast Enhanced Computed Tomography in Assessing Tumour Spread Patterns and Staging of Buccal Carcinoma: A Retrospective Observational Study

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ABSTRACT

Introduction: Buccal mucosa is one of the common subsites of oral cavity cancers. Buccal carcinoma usually shows contiguous extension, involving adjoining anatomical structures; accurate assessment of its extent is necessary for appropriate patient management. Contrast Enhanced Computed Tomography (CECT) is an important imaging modality that helps with disease staging, assessment of preoperative surgical resectability, and radiation planning.

Aim: To evaluate the anatomical pathways of tumour spread and staging characteristics of buccal carcinoma using CECT.

Materials and Methods: This retrospective study was conducted at the Department of Radiodiagnosis and Interventional Radiology, Bhopal Memorial Hospital & Research Center, Bhopal, Madhya Pradesh (MP), India, from November 2023 to October 2024. Total of 100 patients of all age groups with clinically suspected cases of buccal carcinoma were evaluated by a 256-slice multislice CECT machine. The abnormal manifestations measured included involvement of adjacent anatomical structures such as the gingivobuccal sulcus, alveolar ridge, retromolar trigone, masticator space, mandible, skin, floor of mouth, tongue, and regional lymph nodes, were systematically documented on CECT. The imaging findings were subsequently confirmed by histopathological examination of the surgical specimen and/or biopsy samples wherever available. All continuous variables were measured using the mean and SD, and categorical variables using frequencies and percentages.

Results: A total of 100 patients (85 histopathologically confirmed) with clinically suspected buccal mucosal lesions were evaluated. The patient ages ranged from 20 to 70 years, with a mean of 48.6 years. There were 72 males and 28 females (male:female ratio 2.6:1). Histopathological examination confirmed squamous cell carcinoma in 85 patients, while the remaining 15 patients had premalignant conditions. The most common site involved was the parotid duct orifice, seen in 65.4% (56/85) of cases, followed by the gingivobuccal sulcus, 60.2% (51/85). Other sites showing contiguous infiltration included the overlying subcutaneous fat and skin 45.3% (39/85), lips and angle of the mouth 21.2% (18/85), retromolar trigone 25.6% (22/85), mandibular alveolus 43.5% (37/85), maxillary alveolus 38.7% (33/85), muscles of the masticator space 48.2% (41/85), floor of the mouth 30.2% (26/85), oropharynx 30.6% (26/85), maxillary sinus/pterygomaxillary fissure 29.2% (25/85), pterygoid plates 25.4% (22/85), high infratemporal fossa (i.e., above the mandibular notch) 30.6% (26/85), and the base of the skull with intracranial extension 15.7% (13/85)

Conclusion: In this study, CECT effectively demonstrated the extent of buccal carcinoma and the various anatomical pathways of locoregional tumour spread.

Keywords: Oral Malignancy, Staging, Squamous cell carcinomas

INTRODUCTION

Cancer of the buccal mucosa is one of the common cancers in India, particularly in males, because of the high rate of chewing tobacco and betel nuts. Oral cavity cancers account for nearly 50% of all head and neck squamous cell carcinomas [1], and buccal carcinoma accounts for approximately 30-35% of all cancers in China [1].

Superficial extension of a buccal mass can be visualised directly by clinical examination; however, its deep extension cannot be adequately assessed clinically. Multislice CECT of the face and neck provides valuable information regarding the site and locoregional extent of the primary tumour, spread into adjacent structures, erosion of adjoining bones, involvement of the mandibular canal and neurovascular bundles, and metastatic cervical lymphadenopathy [1,2]. Therefore, CECT plays a crucial role in assessing tumour resectability, planning surgical excision with adequate tumour-free margins, and delineating radiotherapy treatment fields. However, limited Indian studies have comprehensively evaluated the anatomical pathways of tumour spread on multidetector CECT. Hence, the current study aimed to evaluate the various pathways involved in the spread of buccal carcinoma.

MATERIALS AND METHODS

This retrospective observational study was conducted in the Department of Radiodiagnosis and Interventional Radiology, Bhopal Memorial Hospital and Research Centre (BMHRC), Bhopal, Madhya Pradesh, India, from November 2023 to October 2024. The study was approved by the BMHRC Institutional Ethics Committee under approval number IEC/02/Radiology/23.

Inclusion criteria: All patients presenting with clinically suspected buccal mucosal abnormalities, such as induration, surface ulceration, or ulceroproliferative growth and referred for radiological evaluation were included in the study. Patients of all age groups and both genders were enrolled.

Exclusion criteria: Patients with a prior history of surgery presenting with recurrent disease and those who had previously undergone radiotherapy were excluded from the study.

Study Procedure

All imaging examinations were independently interpreted by two board-certified radiologists, each with more than five years of post-residency experience, and the imaging findings reported in this manuscript represent the consensus interpretation.

Contrast-Enhanced Computed Tomography (CECT) protocol: The CECT of the face and neck was performed on a 256-slice Siemens Somatom Drive scanner. Patients were scanned in the supine position, and the puffed-cheek manoeuvre was routinely employed to separate the buccal mucosa from the gingival mucosa and improve lesion delineation. Imaging was obtained from the skull base to the thoracic inlet following intravenous administration of iodinated contrast medium (0.2 mL/kg; acquisition parameters: 5 mm sections reconstructed to 0.625 mm slices with multiplanar reformations). Tumours were staged according to the AJCC staging system [Table/Fig-1,2] [2,3].

Category	Stage	Description
T	T1	Tumour ≤2 cm in greatest dimension
T	T2	Tumour >2 cm but ≤4 cm
T	T3	Tumour >4 cm
T	T4a	Invades cortical bone, deep tongue muscles, maxillary sinus, or facial skin
T	T4b	Invades masticator space, skull base, or encases internal carotid artery
N	N0	No regional lymph node metastasis
N	N1	Single ipsilateral lymph node ≤3 cm
N	N2	Multiple or bilateral nodes ≤6 cm
N	N3	Lymph node >6 cm
M	M0	No distant metastasis
M	M1	Distant metastasis

[Table/Fig-1]: TNM staging for squamous cell carcinoma of buccal mucosa.

Stage	TNM staging	Criteria
I	T1N0M0	Tumour size <2 cm
II	T2N0M0	Tumour size= 2-4 cm
III	T3N0M0 or T1/T2/T3N1M0	Tumour size >4 cm or ipsilateral node <3 cm
IV	T4N0M0 or T1/T2/T3N2/N3M0 or M1	Invasive lesions infiltrating skin and eroding bone. All N2N3 lesions- bilateral or multiple ipsilateral nodes. All M1lesions -distant metastasis

[Table/Fig-2]: Staging criteria for buccal carcinoma.

Clinical and imaging data were retrospectively collected from routine diagnostic records using a structured proforma, with all examinations performed as part of standard clinical care after obtaining informed consent.

STATISTICAL ANALYSIS

Statistical analysis was carried out using the Statistical Package for the Social Sciences version 28.0. (IBM Corp., Armonk, NY). All continuous variables were measured using the mean and SD, and categorical variables using frequencies and percentages. Fisher's-exact test was used to compare categorical variables.

RESULTS

Of 100 cases, 85 were malignant (histopathologically proven squamous cell carcinoma). The remaining 15 cases had benign or premalignant lesions on histopathological examination. The patients' ages ranged from 20 to 70 years (mean age, 48.6 years). The maximum number of patients (45%) belonged to the 41-50 year age group [Table/Fig-3].

There was a male predominance, with 72 male patients and 28 female patients (male-to-female ratio 2.6:1). A history of tobacco and/or betel nut chewing was present in 60 of 85 patients (70.6%) with histopathologically proven buccal carcinoma, compared with five of 15 patients (33.3%) with non malignant lesions. This association was statistically significant (Fisher's-exact test, p=0.008). Most patients presented with locally advanced disease (T4a and T4b), and 48 of the 85 malignant cases were diagnosed as Stage IV disease [Table/Fig-4].

Age groups (in years)	n (%)
20-30	3 (3%)
31-40	24 (24%)
41-50	45 (45%)
51-60	19 (19%)
61-70	9 (9%)

[Table/Fig-3]: Age distribution of the sample (N=100).

T stage	T1	T2	T3	T4a	T4b	
No. of patients	9	10	12	36	18	
N stage	N0	N1	N2a	N2b	N2c	N3
No. of patients	10	16	6	39	9	5
M stage	M0	M1				
No. of patients	73	12				
Overall staging	I	II	III	IV		
No. of patients	9	12	16	48		

[Table/Fig-4]: TNM stage wise distribution of buccal carcinoma (total no. of patients with histopathologically proven malignant mass, n=85).

The most common site involved was the opening of the parotid duct (65.4%), followed by the gingivobuccal sulcus (60.2%) [Table/Fig-5].

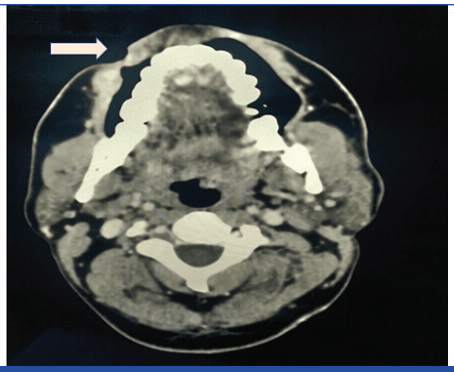
Site of involvement	n (%)
Parotid duct opening	56 (65.4)
Gingivobuccal sulcus	51 (60.2)
Muscles of masticator space	41 (48.2)
Overlying subcutaneous fat and skin	39 (45.3)
Mandibular alveolus	37 (43.5)
Maxillary alveolus	33 (38.7)
Oropharynx	26 (30.6)
High infratemporal fossa (above mandibular notch)	26 (30.6)
Floor of mouth	26 (30.2)
Maxillary sinus/pterygomaxillary fissure	25 (29.2)
Retromolar trigone	22 (25.6)
Pterygoid plates	22 (25.4)
Lips/angle of mouth	18 (21.2)
Base of skull with intracranial extension	13 (15.7)

[Table/Fig-5]: Distribution of common sites involved in buccal malignancy (n=85). Total number of patients: n=85; Multiple sites of involvement could be present in the same patient; therefore, frequencies do not sum to 85

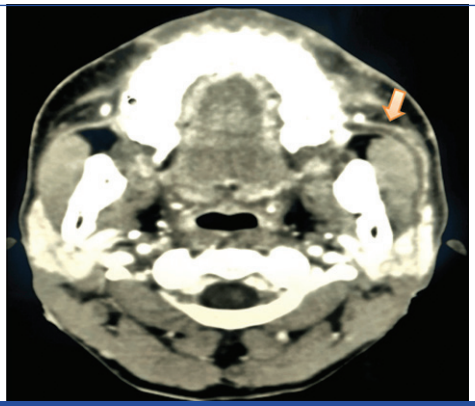
Seven patients had contralateral buccal lesions that were not detected on clinical examination but were clearly identified on CECT as heterogeneously enhancing plaque-like mucosal thickening of the buccal mucosa. Eleven patients had restricted mouth opening during initial CT acquisition. Assisted oral cavity distension using the puffed-cheek technique improved lesion visualisation of the primary lesion [Table/Fig-6].

The most common pattern of disease infiltration involved the underlying submucosa, buccinator muscle, and the opening of the parotid duct. In several patients, obstruction of the parotid duct opening resulted in upstream ductal dilatation associated with thickened and irregular ductal walls [Table/Fig-7].

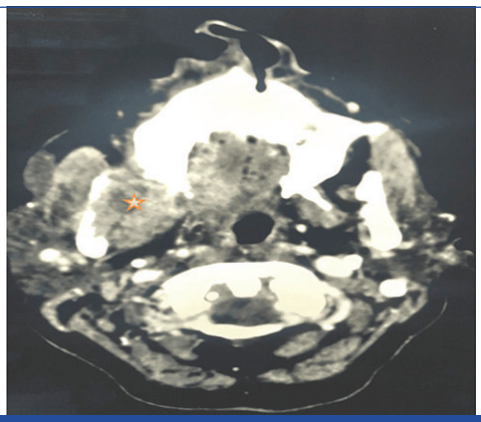
Posterior extension into the bucco-masseteric region and masticator space represented another frequent route of tumour spread [Table/Fig-8].



[Table/Fig-6]: Axial CECT image with puffed cheek manoeuvre showing heterogeneously enhancing irregular soft tissue thickening involving right buccal mucosa with overlying skin puckering (arrow).

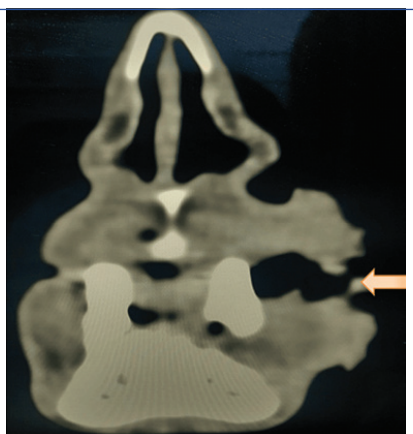


[Table/Fig-7]: Axial CECT image showing involvement of the opening of the left parotid duct by the buccal lesion with resultant upstream dilation associated with thickened and irregular walls(arrow).



[Table/Fig-8]: Axial CECT image showing infiltration of right medial pterygoid and masseter muscles by buccal tumour (star).

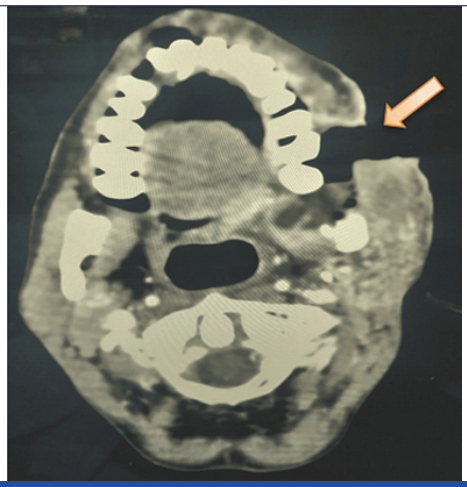
Anterior extension into the orbicularis oris, angle of mouth and adjoining lips was observed in 21.2% of patients and was best appreciated on coronal reformatted images [Table/Fig-9].



[Table/Fig-9]: Coronal CECT image showing involvement of left-side angle of mouth (arrow).

Lateral spread into the overlying skin and subcutaneous tissues was identified in 45.3% of cases. On CECT, this appeared as linear reticulations within the subcutaneous fat associated with thickening and puckering of the adjacent skin [Table/Fig-10]. A few locally advanced lesions also demonstrated the formation of oro-cutaneous fistulae [Table/Fig-11].

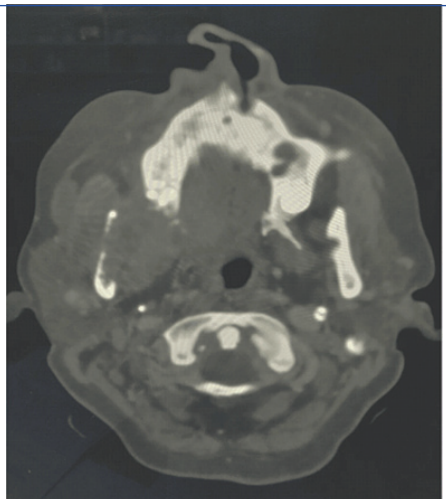
[Table/Fig-10]: Axial CECT image of a case of left buccal mucosa carcinoma showing contiguous infiltration of overlying subcutaneous fat and skin (arrow).



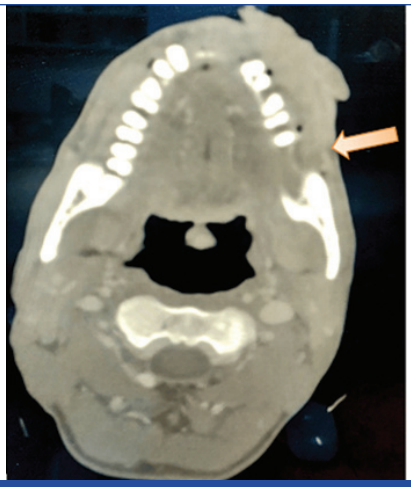
[Table/Fig-11]: Axial CECT image of a locally advanced necro-ulcero-proliferative growth of left buccal mucosa with oro-cutaneous fistula formation (arrow).

Superior and inferior extension into the gingivobuccal sulcus was observed in 60.2% of patients and was optimally demonstrated on coronal multiplanar reconstructions.

Medial extension across the alveolar ridges resulted in maxillary alveolar involvement in 38.7% of patients [Table/Fig-12] and mandibular alveolar involvement in 43.5% [Table/Fig-13]. Posterior



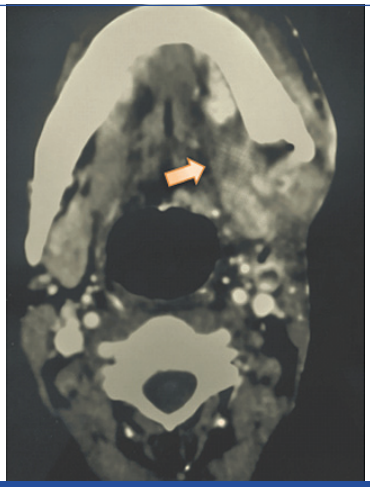
[Table/Fig-12]: Axial CECT image showing erosion of right upper alveolus and vertical ramus of right hemimandible by an infiltrative right buccal mass.



[Table/Fig-13]: Axial CECT image showing erosion of the left mandibular alveolus with involvement of the mandibular canal (arrow).

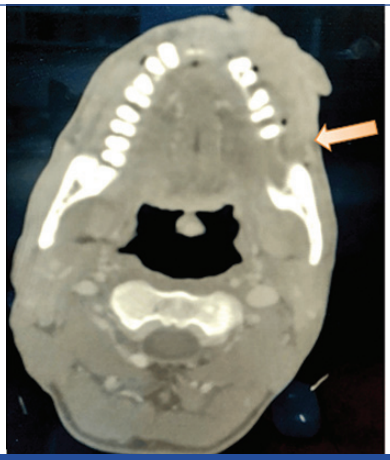
maxillary involvement permitted extension into the maxillary sinus and pterygomaxillary fissure in 29.2% of malignant lesions. Mandibular canal involvement was also identified in a subset of patients.

Inferior extension into the floor of mouth was observed in 30.2% of cases [Table/Fig-14]. Early floor-of-mouth involvement was characterised by infiltration of the sublingual fat space before direct muscular invasion.



[Table/Fig-14]: Axial CECT image showing invasion of left-side of floor of mouth and erosion of left mandibular ramus by an infiltrating buccal tumour (arrow).

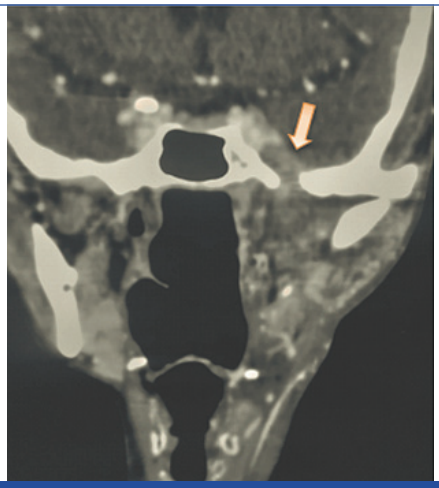
Posterior extension into the retromolar trigone was identified in 25.6% of patients. Further medial spread into the parapharyngeal region and oropharyngeal wall was observed in 30.6% of cases [Table/Fig-15], with extension to the tonsillar pillars, soft palate, and base of tongue in advanced disease.



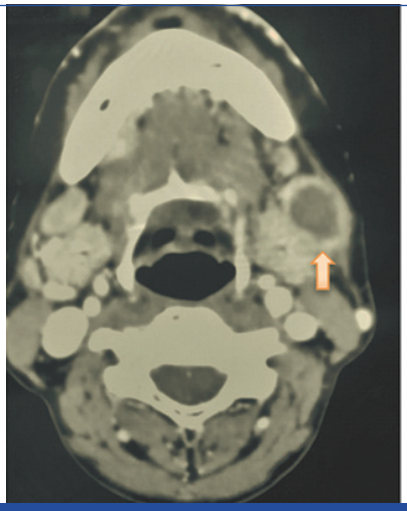
[Table/Fig-15]: Axial CECT image showing a large heterogeneously enhancing necrotic infiltrating buccal mass in right retro-molar trigone and extending medially to involve adjoining parapharyngeal region and right-side base of tongue (star).

Superior progression resulted in widening and erosion of skull-base foramina with intracranial extension in 15.7% of patients [Table/Fig-16], suggesting advanced disease with possible perineural or direct skull-base spread.

Metastatic cervical lymph nodes commonly demonstrated enlargement, heterogeneous enhancement, and central necrosis on CECT [Table/Fig-17]. Nodal disease ranged from discrete enlarged nodes to conglomerate nodal masses.



[Table/Fig-16]: Coronal CECT image shows a large volume heterogeneously enhancing buccal growth causing widening of left foramen ovale leading to intracranial extension (arrow).



[Table/Fig-17]: Axial CECT image showing enlarged, necrotic metastatic left submandibular lymph node (level 1b) in a patient with carcinoma of left buccal mucosa (arrow).

DISCUSSION

Buccal mucosa is a common subsite of oral cavity cancers and accounts for a substantial proportion of oral malignancies in India. In the present study, 85 of 100 patients were diagnosed with histopathologically proven squamous cell carcinoma of the buccal mucosa. A clear male predominance was observed, with a male-to-female ratio of 2.6:1. Similar male predominance has been reported by Sankaranarayanan R, who documented a ratio of approximately 2:1, reflecting the higher prevalence of tobacco and betel nut chewing habits among males in the Indian population [4]. Similar epidemiological trends have also been reported by Nikhilendra Reddy AVS et al., who evaluated 50 patients with buccal mucosa carcinoma and observed that the fourth decade (30%) and fifth decade (26%) saw the highest incidence of buccal mucosa cancer [5].

In the present study, history of tobacco or betel nut chewing was present in 70.6% (60/85) of patients with buccal carcinoma compared with 33.3% (5/15) of patients with non malignant lesions, demonstrating a significant association between these habits and

buccal carcinoma (Fisher's exact test, p=0.008). Nikhilendra Reddy AVS et al., in their study, also emphasised the strong association between tobacco-related habits and the increasing burden of buccal carcinoma in India [5].

The spread pattern of buccal carcinoma mirrors these anatomical communications. In the present study, the most common site of involvement was the parotid duct opening (65.4%), followed by the gingivobuccal sulcus (60.2%). Tumour infiltration typically begins in the submucosa and buccinator muscle before extending into adjacent soft tissues and deep fascial spaces. Involvement of the parotid duct opening, located opposite the second maxillary molar, may produce ductal dilatation and wall thickening, serving as useful ancillary imaging signs. Similar patterns of locoregional spread have been described by Nikhilendra Reddy AVS et al., [5].

The retromolar trigone acts as an important crossroads for disease dissemination. In the present study, retromolar trigone involvement was observed in 25.6% of patients. Owing to its continuity with the soft palate, anterior tonsillar pillar, floor of mouth, and parapharyngeal space, tumour involvement permits extension into the oropharynx, which was identified in 30.6% of cases. This pattern was comparable to that reported by Xu SS et al., [1].

Another notable aspect of the study was the use of the puffed-cheek technique in patients with restricted oral opening. Trismus and pain frequently limit separation of mucosal surfaces, resulting in partial-volume averaging and reduced lesion conspicuity. Assisted oral cavity distension improved visualisation of mucosal thickening, tumour margins, depth of invasion, and extension into adjacent structures, including the gingivobuccal sulcus, retromolar trigone, and masticator space. This simple and reproducible technique enhanced assessment of tumour extent and may improve staging accuracy in selected patients.

The majority of patients in the present study presented with advanced disease, with 56.5% (48/85) classified as Stage IV. This finding is comparable to that reported by Nikhilendra Reddy AVS et al., who observed Stage IV disease in 58% of patients, highlighting the tendency for buccal carcinoma to present at an advanced stage in the Indian population [5].

Regional lymphatic spread remains an important determinant of prognosis. The buccal mucosa primarily drains to the submental and submandibular lymph nodes before involving other cervical nodal stations [6].

The CECT has superior sensitivity for detecting cortical bone erosion and osseous involvement, making it the imaging modality of choice for assessing bony invasion in buccal carcinoma. In the present study, mandibular alveolar involvement was identified in 43.5% of patients and maxillary alveolar involvement in 38.7%, highlighting the frequency of osseous extension in locally advanced disease. Desai NC et al., demonstrated high sensitivity of CT for detecting mandibular bone invasion in buccal carcinoma [7]. Similarly, Nikhilendra Reddy AVS et al., reported that CT detected mandibular cortical erosion with an accuracy approaching 98% and was highly effective in demonstrating extension into the infratemporal fossa and other deep facial spaces [5]. Collectively, these findings highlight the importance of meticulous anatomical evaluation and accurate CT staging in treatment planning, prognostication, and determination of surgical resectability in buccal carcinoma.

Limitation(s)

The present study is limited by exclusive reliance on CT imaging. Retrospective study design. Single-centre study. Histopathological correlation of every anatomical extension was not feasible in all patients.

CONCLUSION(S)

The CECT demonstrated excellent utility in delineating the anatomical extent and locoregional spread of buccal carcinoma, providing information relevant to staging and surgical planning.

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