International Journal of Research in Medical Sciences
Bamdhamravuri SK et al. Int J Res Med Sci. 2024 Jul;12(7):2410-2416
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20241890

Original Research Article

Role of multidetector computed tomography and magnetic resonance imaging in evaluation of buccal mucosal neoplasms

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Received: 27 April 2024
Revised: 04 June 2024
Accepted: 17 June 2024

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ABSTRACT

Background: Buccal mucosa cancers are increasingly common among younger individuals, primarily due to tobacco usage. Accurate staging is essential for effective treatment planning. This study evaluates the role of multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) in assessing buccal mucosa neoplasms.
Methods: This prospective study included 25 patients from Great Eastern medical school and hospital over a 12-month period. All patients underwent initial clinical examination followed by CT and MRI scans. CT scans were conducted using a GE 16-slice MDCT scanner, and MRI scans were performed with a 1.5-T unit. Imaging results were correlated with histopathological findings. The TNM classification system was used for disease staging.
Results: CT and MRI demonstrated high sensitivity (98%) in detecting bone erosion and invasion into the infratemporal fossa. MDCT effectively identified the extent of bone involvement, while MRI provided detailed soft tissue contrast, aiding in the evaluation of surgical outcomes. Imaging accurately identified key features impacting staging and treatment, including involvement of the retromolar trigone, tongue, masticator space, bones, neurovascular bundles, lymph nodes, and distant metastases.
Conclusions: MDCT and MRI are non-invasive, cost-effective tools critical for the staging and management of buccal mucosa cancer. Early and accurate imaging significantly improves treatment planning and prognostication. Both modalities play complementary roles in assessing disease extent and guiding clinical decisions.

Keywords: Buccal mucosa, Neoplasms, MDCT, MRI, Cancer staging, Imaging, Squamous cell carcinoma

INTRODUCTION

Squamous cell carcinoma ranks as the most common neoplasm affecting the buccal mucosa.[1] Accurate imaging of oral cavity tumors is paramount for delineating the size and extent of the primary lesion, crucial for surgical planning and radiotherapy.[2] Precise localization aids in achieving adequate resection margins, defining radiotherapy fields, and ultimately, enhancing patient prognosis.

Understanding the anatomical nuances and typical routes of squamous cell carcinoma spread from various primary sites is fundamental for diagnostic accuracy, disease stratification, and treatment optimization.[3]

Within the Indian population, buccal mucosa stands out as the predominant site for oral cancer incidence. The heightened prevalence in India is largely attributed to widespread habits such as gutkha and betel quid chewing, often with tobacco, which elevate the risk of developing oral submucous fibrosis, a premalignant condition.[4] Risk factors for buccal carcinoma encompass habits like areca nut/betel leaf/tobacco chewing, tooth extraction, heavy alcohol consumption, HPV infection, Candidiasis, and premalignant lesions such as leukoplakia, erythroplakia, and oral submucosal fibrosis.[5] MDCT emerges as a

readily available, non-invasive, and cost-effective imaging modality for assessing squamous cell carcinoma of the buccal mucosa, facilitating precise staging.[6] MDCT accurately delineates crucial features impacting staging and treatment planning, including involvement of the retro molar trigone, tongue muscles, masticator space, bones, neurovascular bundles, and lymph nodes/distant metastases.[7]

Utilizing the puffed cheek CT technique offers a straightforward approach for obtaining detailed evaluations of the buccal and gingival mucosa within the oral cavity.[8]

Cross-sectional imaging assumes a pivotal role in the pre-operative assessment of buccal mucosa cancer, furnishing precise lesion extent details to guide management decisions and prognostic assessment.[9]

Objectives

This study aims to assess the contribution of CT and MRI in the management of buccal mucosal neoplasms, focusing on delineating imaging features such as the size and extent of the primary lesion, architectural details, growth patterns, bony erosions, presence of lymph nodal deposits, and specific MR signal characteristics and contrast enhancement patterns.

Disease staging was conducted utilizing the TNM classification system.

METHODS

The source of data for the study is 25 patients from Great Eastern medical school and hospital.

Duration of study

The study conducted for 12 months

Data analysis

Data analysis done by prospective study.

All patients referred to the department of radio-diagnosis with either suspected or diagnosed primary bone tumors in a period of 12 months from August 2022 to July 2023 are taken for the study.

A detailed history is taken followed by clinical examination. All patients are first evaluated with CT examination followed by MRI evaluation. The patients are then followed up with regard to histopathological correlation.

All CT scans were conducted using a GE 16-slice MDCT scanner with a collimation of 40×0.625 mm, slice thickness of 0.6mm, and 16 slices per rotation.

Multiplanar sagittal and coronal reformation images were obtained using multi planar imaging (MIP) and 3D reconstruction algorithm. All images with MRI were obtained with a 1.5-T unit and either a neck coil or a head and neck coil.

Puffed cheek manoeuvre was performed to separate gingival and oral buccal mucosa in all the cases for improved detailed evaluation.

Inclusion criteria

All the patients referred to radiology department for CT and MRI imaging and were histopathological proven cases of squamous cell carcinoma of buccal mucosa (before or after imaging) were included.

Time interval between patients who underwent biopsy first and later imaging or patients who already undergone imaging followed by biopsy and histopathological confirmation-less than 30 days.

Exclusion criteria

Post op case of buccal mucosa cancer, patients who have taken chemotherapy/radiotherapy for buccal mucosa cancer, recurrence of buccal mucosa cancer and time interval more than one month between histopathological confirmation and imaging were excluded.

Anatomy of buccal mucosa

The oral cavity comprises the anterior two-thirds of the tongue, the floor of the mouth, the mandibular and maxillary alveoli, the hard palate, the lips, and the cheeks (also known as the bucco-masseteric region). The buccal mucosa lines the upper and lower alveoli.[10]

The gingivo-oral mucosa runs along the alveolar bony margins, while the gingivobuccal mucosa is situated along the buccal mucosal surface.[10]

Adjacent to the buccal mucosa lies the buccal fat space, which is bordered laterally by the zygomaticus major muscle and medially by the buccinator muscle. This space encompasses the buccal fat, facial artery and vein, buccal artery, and nerves (not identifiable on imaging), as well as the terminal portion of the parotid duct and the facial lymph node.

Superiorly, this space transitions into the masticator space, often with incomplete fascial boundaries between them.[10]

Posteriorly, the buccal mucosa continues seamlessly into the retromolar trigone, a triangular area delimited by the last mandibular molar tooth anteriorly and the anterior surface of the lower ascending ramus of the mandible posteriorly.[10]

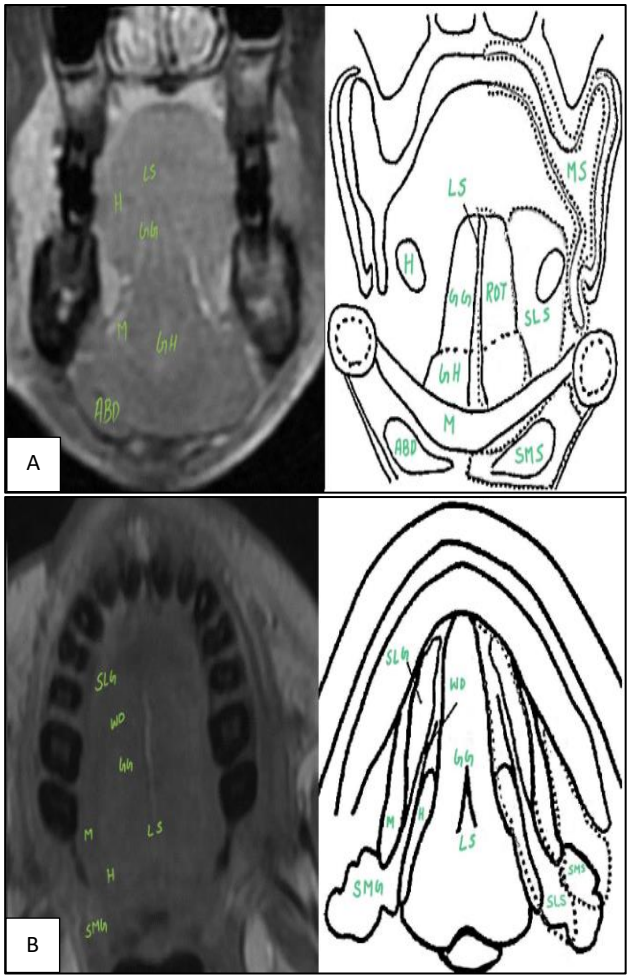

Figure 1 (A and B): Normal oral cavity structures and spaces on coronal T1 weighted MR with schematic diagram. Normal oral cavity structures and spaces (at level of the floor of mouth) on axial T1 weighted MR with schematic diagram.

M-mylohyoid muscle; ABD-anterior belly of digastric muscle; H-hyoglossus muscle; GH-geniohyoid muscle; GG-genioglossus muscle; LS-lingual septum; SLS-sublingual space; SMS-submandibular space; ROT-root of tongue; and MS-mucosal space. SLG-sublingual gland; SMG-submandibular gland; WD- Wharton's duct.

Technique of examination

MDCT technique

MDCT represents a readily available, non-invasive, and cost-effective imaging modality for evaluating squamous cell carcinoma of the buccal mucosa and determining its stage.

A CT scan of the sinuses and neck, ranging from the skull base to the clavicles, was performed with contrast. It included plain, arterial, and venous phase images, along with puffed cheek views for enhanced visualization.

A puffed-cheek CT scan, a simple technique, provided detailed views of the mouth's gum tissue and the area behind the molars to enhance visualization of the superior and inferior gingivobuccal sulcus and the retromolar trigone.

CT scan evaluation was made for size and extent of primary mass lesion.

The disease was considered to be advanced based on CT criteria like bone erosion, skin infiltration, buccal space infiltration and extension to retro molar trigone.

This retrospective case series involved 25 patients diagnosed with squamous cell carcinoma of the buccal mucosa who underwent MDCT, with some also undergoing CEMRI for further evaluation.

MRI technique

Axial and coronal Ti-weighted SE images (500-700/10-20 [TRITE]) were obtained before and after the IV administration of gadopentetate dimeglumine (0.1 mmol/kg) in all patients.

Single-echo T2-weighted FSE images were obtained at TRs of 4500-5200 msec and effective TEs of 90-103 msec, with an echo train length of seven and an echo spacing of 20 msec in the axial plane and in the coronal plane.

Contrast-enhanced MRI (CEMRI) serves as a crucial tool in the pre-operative evaluation of buccal mucosa cancer, providing precise details of lesion extent to inform management decisions and prognosis.

Nodes were evaluated for size, enhancement, and presence of necrosis. Radiological findings were correlated with clinicopathological findings of the lesion.

Disease staging was performed utilizing the TNM classification system.

Table 1: Staging criteria for oral cavity/buccal mucosa cancer based on TNM classification.

Stages	TNM staging	Criteria
I	T1N0M0	Tumour less than 2 cm
II	T2N0M0	Tumour more than 2 cm but less than 4 cm
III	T3N0M0 or T1/T2/T3 -N1 M0	Tumour >4 cm or ipsilateral node <3 cm

Continued.

Stages		TNM staging	Criteria
IV	IV A	T1/T2/T3 -N2 M0 or T4a N0/N1/N2 M0	All N2 lesions. Invasive lesions involving cortical bone, intrinsic or extrinsic muscles of the tongue, maxillary sinus, or skin.
	IV B	T1/T2/T3 -N3 M0 or T4b -N1/N2/N3 M0	All N3 lesions. Invasive lesions infiltrating masticator space, pterygoid plates, skull base or encase the carotid artery.
	IV C	T1/T2/T3/ N1/N2/N3 -M1	All M1 lesions (Distant metastasis)

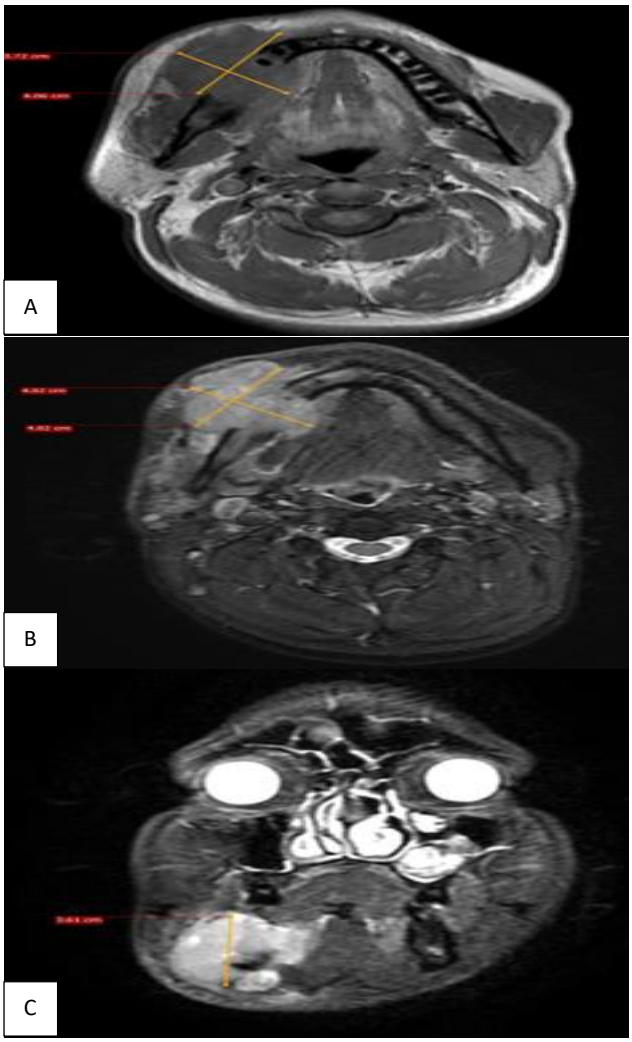

Figure 2 (A-C): Heterogeneously enhancing mass lesion with central T2, STIR hyperintensity and T1 iso intensity of size 4.3×4.4×3.7 cm arising from the right buccal space with obliteration of buccal fat of pad, extending up to masticator space, the masseteric fascia laterally and submandibular space inferiorly at C2-6 levels- F/S/O neoplastic etiology of right buccal mucosa T4A N2B (Case 1). Multiple enhancing lymph nodes noted in the bilateral I, II largest measuring 13×11 mm at right II-lymph nodal deposits.

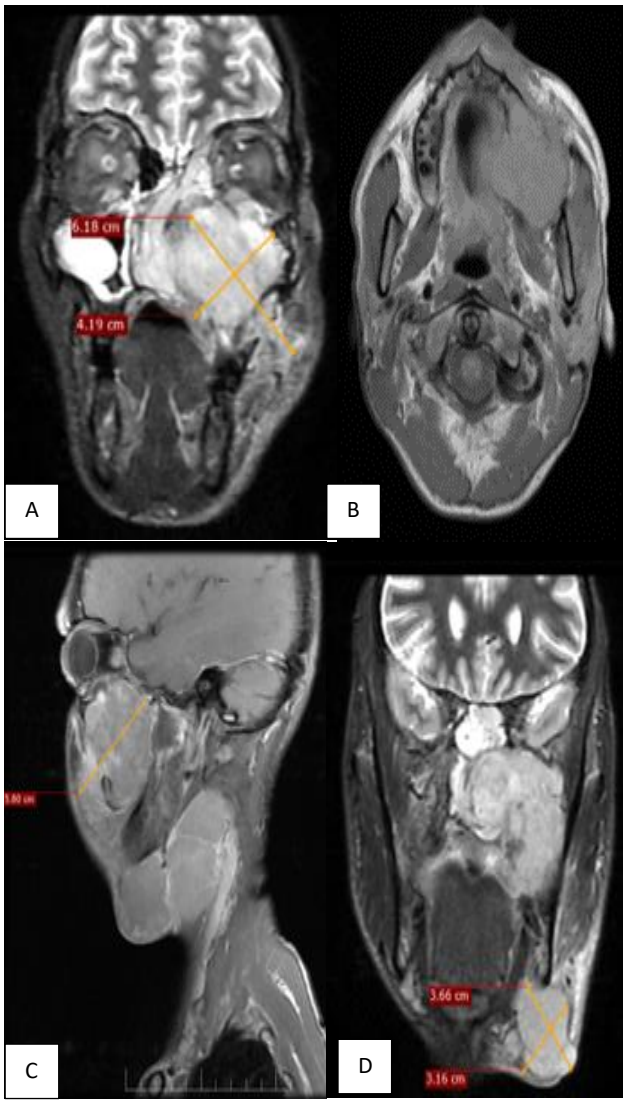

Figure 3 (A-D): An ill-defined homogenously enhancing T2 STIR hyperintense lobulated lesion of size 6.4×6.3×6.7 cm arising from the buccal mucosa of gingival aspect of maxilla, on left side, involving the left masticator space erosion of hard palate, with extension into ipsilateral nasal cavity, erosion of middle and inferior nasal choana, crossing midline by 1.1 cm (Case 2).

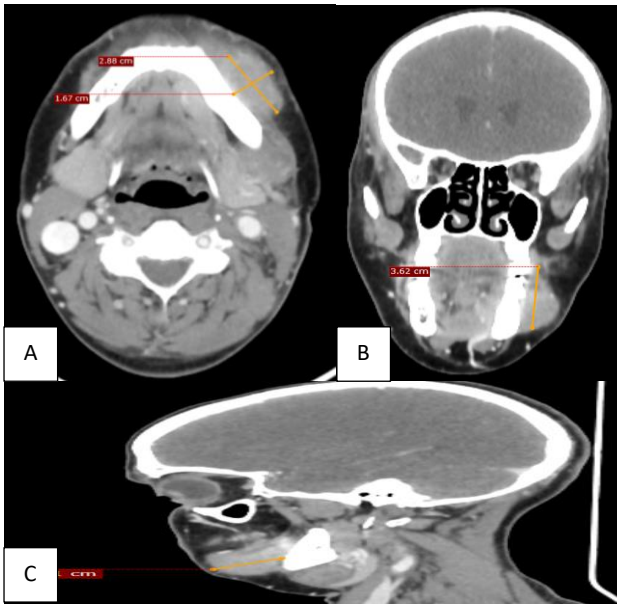

Figure 4 (A-C): Well defined heterogeneously enhancing mass lesion with central hypodense areas of size 3.4×1.8×3.1 cm, surrounding fat stranding noted arising from left buccal space, abutting left mandibular region with obliteration of buccal fat of pad, extending up to retro maxillary space, masticator space, invading masseteric fascia, submandibular space inferiorly at C2-3 levels (Case 3).

Lesion is seen to involve ipsilateral superficial and deep part of masseter muscles, buccinator, temporalis muscles- hence involvement of infratemporal fossa (infranotch)-T4b N2b.

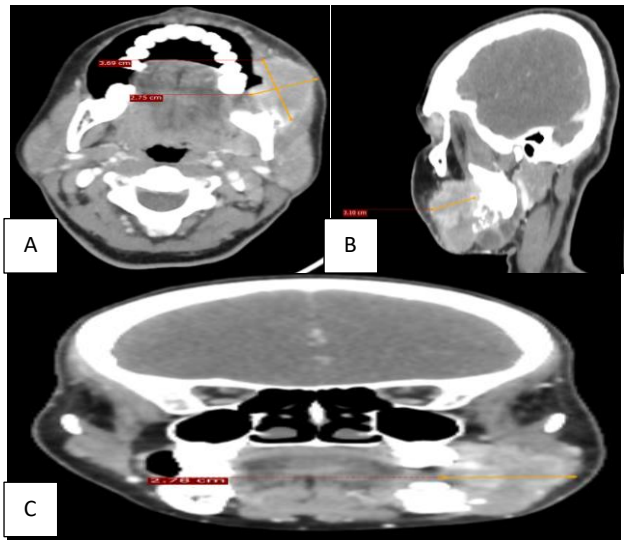

Figure 5 (A-C): Case 4: Well, defined heterogeneously enhancing mass lesion with central hypodense areas of size 3.2×2.5×3.6 cm in the left buccal space with obliteration of buccal fat of pad, extending up to retro maxillary space, complete involvement of left masticator space, invading masseteric fascia laterally and Bucco gingival fascia medially, submandibular space inferiorly at C2-5 levels-T4b N2b.

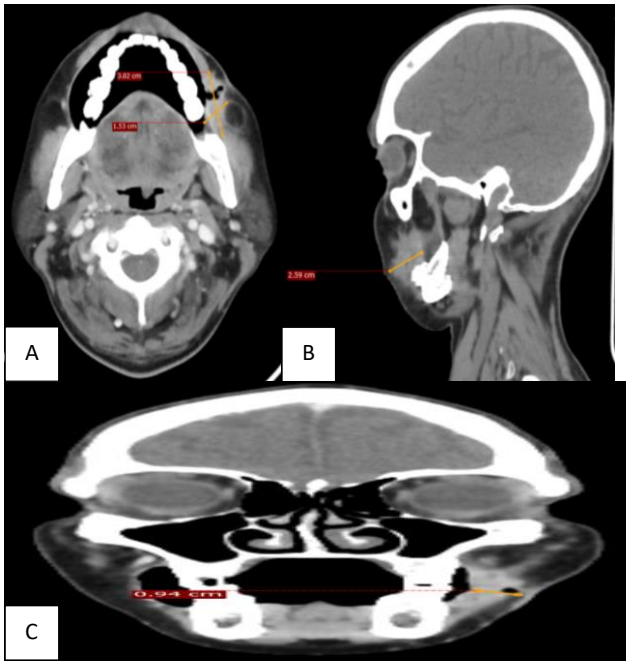

Figure 6 (A-C): Case 5: Well defined heterogeneously enhancing mass lesion with central hypodense areas, few air foci of size 3.3×1.6×3.2 cm, surrounding fat stranding noted arising from left buccal space, abutting left mandibular region with obliteration of buccal fat of pad, masticator space, invading masseteric fascia, submandibular space inferiorly at C2-3 levels.

Extension medially to alveolar process of mandible, with intact fat planes, suspicious loss of fat planes with gingival sulcus. Lesion is seen to involve ipsilateral superficial and deep part of masseter muscles, buccinator, temporalis muscles-hence involvement of infratemporal fossa (infranotch)-Neoplastic etiology (of left buccal mucosa) T3 N2.

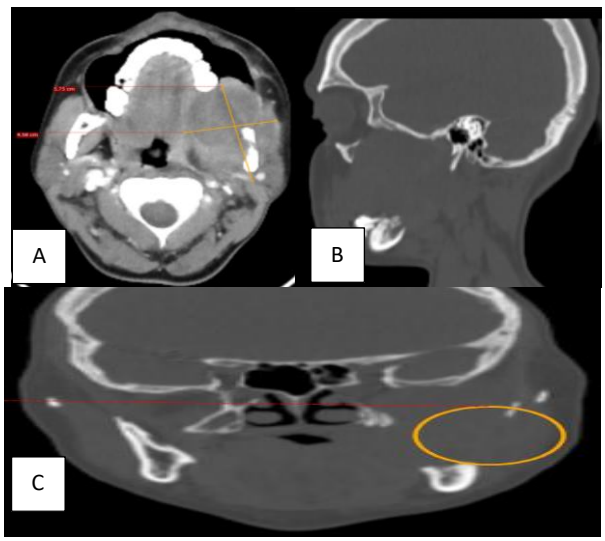

Figure 7 (A-C): Case 6: K/C/O carcinoma left buccal mucosa with both supra and infranotch infratemporal fossa involvement and nodal deposits (increased compared to previous scan) staging: T4b N2b

RESULTS

The provided data shows the sex, age distribution and risk factors of patients. In terms of sex distribution, there are 29 male patients and 11 female patients. Regarding the age distribution, the patients are evenly divided into four age groups: 31-40 years, 41-50 years, 51-60 years, and 61-70 years, with each group comprising 10 patients. While Tobacco use is the most prevalent risk factor, affecting 76% of the patients. This is followed by smoking, which accounts for 13% of the patients. Oral infections are identified in 8% of the patients, while constant trauma is the least common risk factor, affecting 3% of the patients (Table 2).

Table 2: Representing the provided data for the sex , age & risk factors of patients.

Parameters	N (%)
Sex distribution	
Male	29 (72.5)
Female	11 (27.5)
Age distribution (in years)	
31-40	10 (25)
41-50	10 (25)
51-60	10 (25)
61-70	10 (25)
Risk factors	
Tobacco use	30 (76)
Smoking	5 (13)
Oral infections	3 (8)
Constant trauma	1 (3)

TNM staging

The data provided includes the distribution of tumor size and depth of invasion among patients. For tumor size, the distribution is as follows. 8 patients have tumors smaller than 2 cm, 20 patients have tumors between 2 to 4 cm, and 12 patients have tumors larger than 4 cm. Regarding the depth of invasion, 5 patients have a depth of invasion less than 1 cm, while 35 patients have a depth of invasion of 1 cm (Table 3).

Table 3: Distribution of tumor size and depth of invasion.

Parameters	N (%)
Tumor size (cm)	
<2	8 (20)
2-4	20 (50)
>4	12 (30)
Depth of invasion (cm)	
<1	5 (12.5)
≥1	35 (87.5)

The provided data shows the TNM staging distribution among patients. For T staging, the distribution is as follows: 1 patient is at stage TI, 1 patient at stage TII, 5 patients at stage TIII, 13 patients at stage TIVA, and 20 patients at stage TIVB. Regarding N staging, there are no patients at stage N0, 10 patients at stage N1, 25 patients at stage N2, and 5 patients at stage N3. For M staging, 35 patients are at stage M0, while 5 patients are at stage M1 (Table 4).

Table 4: TNM staging distribution.

Parameters	N (%)
T staging	
TI	1 (2.5)
TII	1 (2.5)
TIII	5 (12.5)
TIVA	13 (32.5)
TIVB	20 (50)
N staging	
N0	0 (0)
N1	10 (25)
N2	25 (62.5)
N3	5 (12.5)
M staging	
M0	35 (87.5)
M1	5 (12.5)

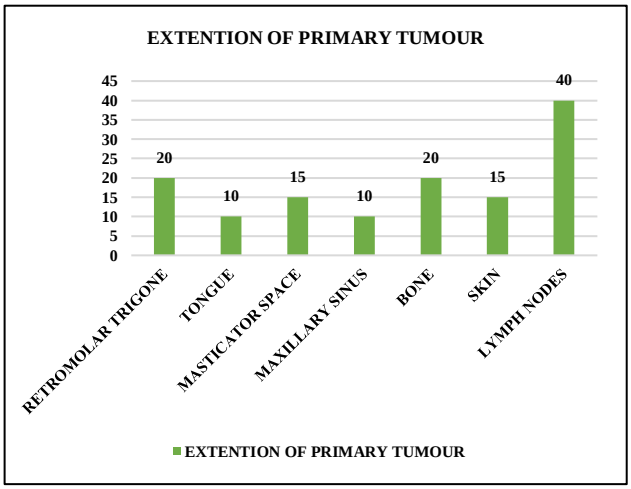

Figure 8: Extension of the primary tumor across different anatomical regions.
The data shows how the primary tumor extends into various parts of the body.

DISCUSSION

MDCT plays a pivotal role in identifying the primary lesion, assessing its extent, and aiding in disease staging.[11] On MDCT and CEMRI imaging, buccal mucosa cancer typically presents as plaque-like thickening, irregular fungating growth, or ulcero-proliferative lesions.[12] In more complex cases, Oro cutaneous fistulas may be observed.

Metastasis of primary buccal mucosa malignancies is uncommon to distant sites, with lymphatic spread and local extension being more prevalent.[13] Metastasis

commonly occurs through direct extension, dissemination via lymphatic drainage pathways, and extension along neurovascular bundles. A comprehensive evaluation of these routes is essential for accurate staging of squamous cell carcinomas (SCCs) of the buccal mucosa. Key structures to assess for buccal mucosa cancer extension on MDCT and CEMRI include the buccal mucosa-buccinator complex, buccal space, superior and inferior gingiva-buccal mucosa, retromolar trigone, pterygoid muscles, masseter muscle, involvement of the mandibular bone and residual height, mandibular canal/perineural spread, parotid duct involvement, and cervical lymph nodes.[14] Although various staging systems exist, the TNM system is the most commonly utilized for buccal mucosa cancer staging.[15]

CONCLUSION

The incidence of buccal mucosa cancers is increasingly alarming among younger individuals, predominantly due to tobacco usage. CT and MRI imaging are crucial in staging buccal mucosa malignancies, with a remarkable sensitivity of 98% in detecting bone erosion and invasion into the infratemporal fossa. The effective planning and execution of treatment heavily rely on the staging information obtained through CT imaging.

MDCT and MRI serve as non-invasive and cost-effective diagnostic tools for evaluating squamous cell carcinoma of the buccal mucosa and determining its stage. Patient recovery hinges significantly on the early detection of cancer, with staging providing valuable insights into potential outcomes. MDCT accurately identifies key imaging features impacting staging and treatment planning, including involvement of the retromolar trigone, tongue muscles, masticator space, bones, neurovascular bundles, lymph nodes, and distant metastases.

MDCT is particularly valuable in assessing the extent of bone involvement, while MRI offers insights into the outcomes of mandible-sparing surgeries such as marginal mandibulectomy.

In summary, timely and accurate imaging staging with MDCT and MRI enhances treatment decision-making and improves prognostication for patients with buccal mucosa cancer.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Bamdhamravuri SK, Nagaraj BR, Kammela R. Role of multidetector computed tomography and magnetic resonance imaging in evaluation of buccal mucosal neoplasms. Int J Res Med Sci 2024;12:2410-6.