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Role of Multidetector Computed Tomography (MDCT) Scan in the Evaluation of Buccal Malignancy

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Abstract:

Background: *Buccal malignancy is an aggressive and common oral cavity cancer in South Asia, often associated with tobacco and betel nut/leaf use, and requires precise imaging for accurate assessment of tumor extent and spread. Therefore, this study aims to evaluate the effectiveness of multidetector computed tomography (MDCT) in assessing tumor extent and staging in patients with buccal malignancy.*

Methods: *This cross-sectional diagnostic accuracy study was conducted at the Departments of Radiology and Imaging, Otolaryngology and Head–Neck Surgery, and Pathology, Sylhet MAG Osmani Medical College and Hospital, Sylhet, Bangladesh, from March 2020 to February 2022. Sixty-five histopathologically confirmed buccal malignancy patients underwent MDCT, followed by surgery and histopathology. Demographic, clinical, radiological, and pathological data were analyzed using SPSS 23.0.*

Results: *Among 65 patients (mean age 52.8 ± 11.1 years; 67.7% male), most tumors involved the buccal mucosa with extensions to the buccogingival sulcus (89.2%) and retromolar trigone (64.6%), bone involvement in 24.6%, and ipsilateral lymph nodes in 77%. Predominantly squamous cell carcinoma (90.2%, grade II–III), MDCT staging closely matched histopathology, especially Stage IVB (92.9%), with high diagnostic accuracy (sensitivity 75–96.3%, specificity 94.5–98.2%).*

Conclusion: *MDCT is a highly accurate and sensitive modality for the evaluation and primary diagnosis of buccal malignancy.*

Keywords: *Multidetector Computed Tomography, Buccal Malignancy, Tumor Staging, Imaging Evaluation, Head and Neck Cancer*

1. INTRODUCTION

Buccal malignancy is the most common oral cavity cancer and is much more prevalent in South Asia than in Europe and the United States [1]. Oral cancer ranks as the sixth most common cancer worldwide, with approximately 85% to 95% of cases being squamous cell carcinoma (SCC) [2]. Other histological types include mucoepidermoid carcinoma, adenocarcinoma, verrucous carcinoma, and adenoid cystic carcinoma [3]. The high incidence of buccal malignancy in Bangladesh is largely attributed to

the widespread use of tobacco products along with betel nut and betel leaf chewing. Buccal malignancy is an aggressive oral cancer characterized by poor survival and high locoregional recurrence, with reported recurrence rates ranging from 30% to 80% [4]. Clinically, patients most commonly present with a non-healing mouth ulcer or sore, followed by a palpable lump [5].

Understanding the anatomy of the buccal space and the pathways of tumor spread is essential for accurate assessment. Buccal malignancy can extend from the gingivobuccal mucosa into the buccal fat space and overlying skin. Evaluation should assess submucosal spread, osseous involvement, extension to the retromolar trigone (RMT), involvement of the muscles of mastication, and cervical lymphatic dissemination. Imaging evaluation of the RMT is particularly important, as clinical examination alone cannot reliably determine lesion involvement in this subsite [6]. The mandible and maxilla are the most commonly affected osseous structures, with mandibular invasion reported in 12% to 56% of cases [7]. Surgical management often involves composite or "commando" resection with segmental or hemi-mandibulectomy [8]. Cervical lymphatic dissemination can sometimes be clinically detectable but is more accurately assessed using imaging [6]. Lymph node evaluation includes assessment of enlargement, shape alteration, enhancement, and necrosis, with level I, II, and III nodes most frequently involved; metastasis to level IV and V nodes is rare and typically occurs in advanced primary tumors or poorly differentiated lesions [9].

Although buccal malignancy can be observed clinically, deeper extension is often difficult to evaluate, highlighting the importance of imaging. Common imaging modalities for preoperative assessment include panoramic radiography, ultrasonography (USG), computed tomography (CT), magnetic resonance imaging (MRI), and fluorodeoxyglucose-positron emission tomography (FDG-PET). Panoramic radiographs have demonstrated sensitivity and specificity of 87% and 80%, respectively, for detecting mandibular invasion but are limited in detecting early bony involvement [10]. USG is mainly used for lymph node assessment and biopsy guidance, though it's utility is limited for deep or posterior lesions and those obscured by bone [11]. MRI offers excellent soft tissue contrast and delineates lesion margins more clearly, particularly on T2-weighted images with fat suppression, which is useful for evaluating the buccal space and surrounding structures [3]. FDG-PET is valuable for detecting distant metastasis and synchronous or unknown primary tumors, although it cannot reliably differentiate tumor from inflammation due to similar hypermetabolic activity [12].

Multidetector computed tomography (MDCT) has emerged as a frontline imaging modality for buccal malignancy. Advanced disease is assessed based on MDCT criteria such as bone erosion, skin infiltration, buccal fat infiltration, and RMT involvement [13]. Superficial mucosal and submucosal lesions are well visualized using puffed-cheek contrast-enhanced CT, particularly in coronal reformats, which improves visualization of the gingivobuccal sulcus and gingiva [14]. MDCT accurately evaluates staging-relevant features including RMT, masticator space, tongue muscles, bones, neurovascular bundles, lymph nodes, and distant metastasis. For cortical bone invasion, MDCT is superior, whereas MRI is more sensitive for marrow involvement and perineural spread [15]. MDCT also guides surgical planning, including the feasibility of mandible-sparing procedures like marginal mandibulectomy [15]. In studies abroad, MDCT has shown high diagnostic performance for buccal carcinoma, with sensitivities of 86.2%–100%, specificity of 91%–95.3%, and accuracy up to 93.6% [10, 16, 17]. Despite these findings, literature on the role of MDCT for buccal malignancy evaluation in Bangladesh remains limited, which underscores the need for the present study. So, the present study aims to assess the effectiveness of Multidetector Computed Tomography (MDCT) in assessing tumor extent and staging in buccal malignancy.

2. Objective

To evaluate the effectiveness of Multidetector Computed Tomography (MDCT) in assessing tumor extent and staging in buccal malignancy.

3. Methodology & Materials

This cross-sectional diagnostic accuracy study was conducted at the Department of Radiology and Imaging in collaboration with the Departments of Otolaryngology and Head–Neck Surgery and Pathology, Sylhet MAG Osmani Medical College and Hospital, Sylhet, Bangladesh, from March 2020 to February 2022. A total of 65 patients with histopathologically confirmed buccal malignancy were included

using a non-probability convenience sampling technique.

3.1. Inclusion Criteria

- Patients referred to the Radiology and Imaging Department with histopathologically confirmed buccal malignancy.
- Patients who subsequently underwent operative treatment.

3.2. Exclusion Criteria

- Previously treated cases of buccal carcinoma (surgery, chemotherapy, radiotherapy, or combined modality treatment).
- Pregnant women.
- Patients with renal impairment.

All included patients underwent MDCT evaluation prior to surgery. CT-related variables assessed included lesion location, size, margin (regular, irregular, or ill-defined), local extensions (retromolar trigone, gingivobuccal sulcus, masticator space, tongue muscles, and skin), contrast enhancement (homogeneous or heterogeneous), bone involvement (maxilla, mandible, or both), and cervical lymph node characteristics (size, number, and laterality). Histopathological variables included lesion type and grade, while demographic and clinical data collected included age, sex, smoking habits, and betel nut/leaf use.

After obtaining written informed consent, CT scanning of the face and neck was performed from the paranasal sinus to the clavicle using a 160-detector multi-interval CT scanner (Aquillion 160, Toshiba, Tokyo, Japan) with 2 mm axial slices at 2–5 mm intervals. Multiplanar and 3D reformatted images were obtained, and the puffed cheek maneuver was performed to improve visualization of the buccal mucosa. Surgery was carried out under general anesthesia according to clinical and radiological findings, and resected specimens were sent for histopathological examination with margin assessment.

Data were recorded using a structured questionnaire prepared by the researcher and analyzed using SPSS version 23.0. Descriptive statistics were reported as means and percentages, and Chi-square tests were applied for categorical variables, with $p < 0.05$ considered statistically significant. Ethical approval was obtained from the Sylhet MAG Osmani Medical College Ethical Committee, and patient confidentiality was maintained throughout the study.

4. Results

Table 1. *Demographic and Lifestyle Characteristics of the Study Participants (n = 65)*

Variable		Number of Patients	Percentage (%)
Age (years)	30–39	7	10.8
	40–49	19	29.2
	50–59	23	35.4
	60–69	13	20.0
	70–76	3	4.6
	Mean ± SD	52.8 ± 11.1	
	Range (min–max)	30–76	
Sex	Male	44	67.7
	Female	21	32.3
Smoking Habit	Yes	42	64.6
	No	23	35.4
Betel Nut/Leaf Habit	Yes	52	80.0
	No	13	20.0

The majority of patients were aged 50–59 years (23 patients, 35.4%), followed by 40–49 years (19 patients, 29.2%) and 60–69 years (13 patients, 20.0%), with a mean age of 52.8 ± 11.1 years (range 30–76 years). Male patients predominated (44 patients, 67.7%). Regarding lifestyle habits, 42 patients (64.6%) were smokers, and 52 patients (80.0%) had a habit of chewing betel nuts and betel leaf

Table 2. *MDCT Characteristics of Buccal Malignancy in Study Participants (n = 65)*

MDCT Variables		Number of Patients	Percentage (%)
Location	Buccal mucosa	65	100.0
Size of lesion (cm)	2.2–3.9	26	40.0
	4.1–8.6	39	60.0

Extension	Buccogingival sulcus	58	89.2
	Retromolar trigone	42	64.6
	Masticator space	28	43.1
	Skin	6	9.2
	Muscle of tongue	4	6.1
Margin	Ill defined	9	13.8
	Irregular	53	81.5
	Regular	3	4.7
Contrast Enhancement	Heterogeneous	59	90.8
	Homogeneous	6	9.2
Bone Involvement	Mandible	12	18.5
	Maxilla	2	3.1
	Mandible & Maxilla	2	3.1
	None	49	75.3
Lymph Node Involvement	Bilateral	8	12.3
	Ipsilateral	50	77.0
	None	7	10.8
Lymph Node Size (cm)	1.1–3.0	55	84.6
	3.1–4.3	6	4.6
Number of Lymph Nodes	Single	11	16.9
	Multiple	47	72.4
	Absent	7	10.7

All lesions were located in the buccal mucosa (100%). Lesion size was 2.2–3.9 cm in 26 patients (40.0%) and 4.1–8.6 cm in 39 patients (60.0%). Tumors commonly extended to the buccogingival sulcus (58 patients, 89.2%) and retromolar trigone (42 patients, 64.6%), less frequently to masticator space (28 patients, 43.1%), skin (6 patients, 9.2%), and tongue muscles (4 patients, 6.1%). Most lesions had irregular margins (53 patients, 81.5%) and heterogeneous contrast enhancement (59 patients, 90.8%). Bone involvement occurred in 16 patients (24.6%), predominantly affecting the mandible (12 patients, 18.5%). Lymph node metastasis was mostly ipsilateral (50 patients, 77.0%), with 55 patients (84.6%) measuring 1.1–3.0 cm; multiple nodes were involved in 47 patients (72.4%).

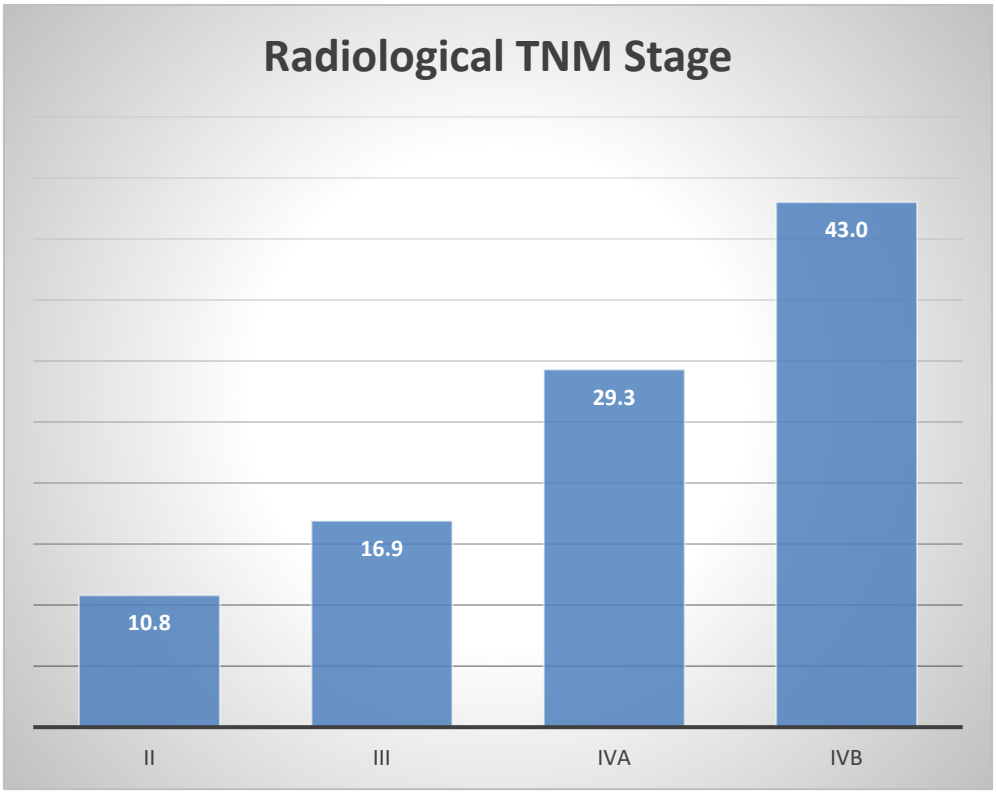

Figure 1. *Radiological TNM Stage of Buccal Malignancy (n = 65)*

According to MDCT evaluation, stage IVB was the most common radiological stage (28 patients, 43.0%), followed by stage IVA (19 patients, 29.3%), stage III (11 patients, 16.9%), and stage II (7 patients, 10.8%).

Table 3. *MDCT and Histopathological Characteristics of Buccal Lesions (n = 65)*

Histopathological Variable		Number of Patients	Percentage (%)
Type	Squamous cell carcinoma	59	90.2
	Verrucous cell carcinoma	3	4.6
	Mucoepidermoid carcinoma	2	3.1
	Adenocarcinoma	1	1.5
Grade of Lesion	I	15	23.1
	II	31	47.7
	III	19	29.2

All lesions involved the buccal mucosa (100%). Lesion size was 2.2–3.9 cm in 40% and 4.1–8.6 cm in 60%. Tumors extended to buccogingival sulcus (89.2%), retromolar trigone (64.6%), masticator space (43.1%), skin (9.2%), and tongue muscles (6.1%). Most had irregular margins (81.5%) and heterogeneous enhancement (90.8%). Bone involvement was 24.6%, mainly mandible (18.5%). Lymph node metastasis was predominantly ipsilateral (77%), multiple (72.4%), and 1.1–3.0 cm (84.6%). Histopathology showed mostly squamous cell carcinoma (90.2%), with grade II (47.7%) and III (29.2%) most common.

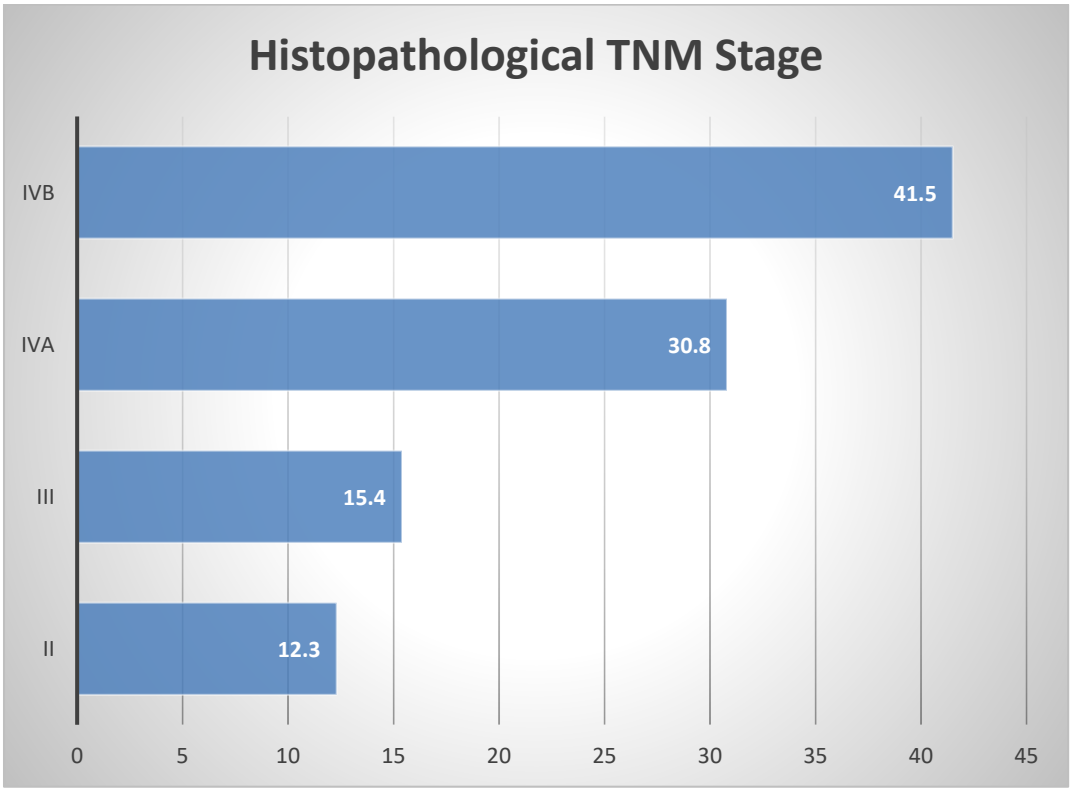

Figure 2. *Distribution of Histopathological TNM Stages in Buccal Lesions (n = 65)*

Most patients had advanced disease, with Stage IVB in 27 patients (41.5%) and Stage IVA in 20 patients (30.8%). Stage III and II were less common, seen in 10 (15.4%) and 8 patients (12.3%), respectively.

Table 4. *Correlation between Radiological and Histopathological TNM Stages in Buccal Lesions (n = 65)*

Radiological Stage	Histopath Stage II	Histopath Stage III	Histopath Stage IVA	Histopath Stage IVB
Stage II	6 (75.0%)	1 (10.0%)	0 (0.0%)	0 (0.0%)
Stage III	2 (25.0%)	8 (80.0%)	1 (5.0%)	0 (0.0%)
Stage IVA	0 (0.0%)	1 (10.0%)	17 (85.0%)	1 (3.7%)
Stage IVB	0 (0.0%)	0 (0.0%)	2 (10.0%)	26 (96.3%)

Radiological staging corresponded closely with histopathology. Most Stage IVB lesions on imaging (26/28, 92.9%) were confirmed histologically, and Stage IVA and III lesions also showed high concordance.

Table 5. *Diagnostic Performance of Radiological TNM Staging Compared to Histopathology (n = 65)*

TNM Stage	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Stage II	75	98.2	95.4	85.7	96.6
Stage III	80	94.5	92.3	72.7	96.3
Stage IVA	85	95.6	92.3	89.5	93.5
Stage IVB	96.3	94.7	95.4	92.9	97.3

Radiological TNM staging demonstrated high diagnostic accuracy for buccal lesions, with sensitivity ranging from 75% (Stage II) to 96.3% (Stage IVB) and specificity from 94.5% to 98.2%. Positive predictive values (PPV) and negative predictive values (NPV) were similarly high.

5. Discussion

This cross-sectional study was carried out in the Radiology and Imaging Department of SOMCH, Sylhet, with the aim of evaluating the sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of MDCT findings compared to histopathology as the gold standard. A total of 65 patients were included in this study after fulfilling the inclusion and exclusion criteria, who were referred to the Department of Radiology and Imaging, SOMCH, Sylhet, between March 2020 and February 2022.

The present study observed that more than one-third (35.4%) of patients belonged to the age group of 50–59 years. The mean age was 52.8 ± 11.1 years, with a range of 30–76 years. Sankhe et al.[18] observed that the age of patients varied from 31 to 70 years, with an equal distribution across age groups: 31–40 years (n=10), 41–50 years (n=10), 51–60 years (n=10), and 61–70 years (n=10). Chhetri et al.[19] reported that patients' ages ranged from 27 to 87 years (mean 67 years). Vidiri et al.[20] found a mean age of 56 years, ranging from 30 to 75 years. Patel et al. [21] observed an age range of 31 to 70 years, while Hoda et al.[9] reported ages ranging from 26 to 74 years.

In this study, 44 patients (67.7%) were male and 21 (32.3%) were female, giving a male-to-female ratio of 2.1:1. Sankhe et al.[18] similarly observed 67% male and 33% female patients. Chhetri et al.[19] reported 67% female patients, whereas Jindal et al.[22] reported 60% females and 40% males, with a female-to-male ratio of 1.5:1. Vidiri et al.[20] observed 26 males (72%) and 10 females (28%). Patel et al.[21] reported 39 males and 11 females. Desai et al.[13] reported 92% male patients and 8% female patients, with a 11.5:1 male-to-female ratio. Oral cavity tumors are the most common cancers in the Indian population, showing a 2:1 male-to-female preponderance. Sankaranarayanan et al.[23] also observed that the incidence of buccal mucosa tumors in males was twice that in females. Hoda et al.[9] reported 149 female and 105 male patients.

The study observed that 42 patients (64.6%) were smokers. Sankhe et al.[18] reported only 5% of patients with a smoking history, whereas Hoda et al.[9] observed that 196/254 patients (77.17%) had a history of tobacco or areca nut use. In the present study, 52 patients (80.0%) had a habit of chewing betel nuts and betel leaf. Sankhe et al.[18] reported 85% of patients with a history of tobacco, areca nut, or betel nut chewing. This trend may be attributed to the higher prevalence of such habits among females, including chewing betel nuts, tobacco, or keeping a betel leaf quid in the mouth (Sharma et al.[24]; Advani[25]; Kalyani et al.[26]).

Regarding MDCT findings, all lesions were located in the buccal mucosa (65 patients, 100%). Lesion size ranged from 2.2–3.9 cm in 26 patients (40.0%) and 4.1–8.6 cm in 39 patients (60.0%). Tumor extension involved the buccogingival sulcus in 58 patients (89.2%), the retromolar trigone in 42 patients (64.6%), the masticator space in 28 patients (43.1%), the skin in 6 patients (9.2%), and tongue muscles in 4 patients (6.1%). Most lesions had irregular margins (53 patients, 81.5%) and heterogeneous contrast enhancement (59 patients, 90.8%). Bone involvement was seen in 16 patients (24.6%), predominantly affecting the mandible (12 patients, 18.5%). Lymph node metastasis was ipsilateral in 50 patients (77.0%), bilateral in 8 patients (12.3%), and absent in 7 patients (10.8%), with 55 patients (84.6%) having nodes

measuring 1.1–3.0 cm. Multiple lymph nodes were involved in 47 patients (72.4%), and single nodes in 11 patients (16.9%).

Sankhe et al. [18] reported that 2 patients (5%) had lesions <2 cm, 21 patients (52%) had lesions 2–4 cm, and 17 patients (43%) had lesions >4 cm. They also observed that 22 out of 40 patients (55%) had extension into the retromolar trigone, and 8 patients (20%) had extension into the extrinsic and intrinsic tongue muscles. Bone involvement was noted in 23 patients (57.5%), including mandible alone (12 patients, 52%), maxilla (8 patients, 35%), and mandible, maxilla, and pterygoid plates together (3 patients, 13%). Among 29 patients (72.5%), regional lymph node metastasis was observed. Jindal et al.[22] reported lymph node metastasis in 74 cases. Desai et al.[13] observed CT was highly reliable (98%) in detecting bone erosion confirmed surgically.

In this study, radiological TNM staging revealed that 28 patients (43.0%) were stage IVB, 19 patients (29.3%) were stage IVA, 11 patients (16.9%) were stage III, and 7 patients (10.8%) were stage II. No patients were stage I. Sankhe et al.[18] reported that among 40 patients, 20 patients (50%) were stage IVB with extension into the masticator space, followed by stage IVA (13 patients, 32.5%), stage II (5 patients, 12.5%), and stage I (2 patients, 4%). No stage III cancers were observed. Patel et al.[21] reported 21 out of 50 patients with T4 stage, 17 patients with T3, 9 patients with T2, and 3 patients with T1 stage.

Histopathological evaluation in this study showed 59 patients (90.2%) had squamous cell carcinoma, followed by 3 patients (4.6%) with verrucous cell carcinoma, 2 patients (3.1%) with mucoepidermoid carcinoma, and 1 patient (1.5%) with adenocarcinoma. Regarding tumor grade, 31 patients (47.7%) were grade II. Patel et al.[21] reported 50 patients with squamous cell carcinoma, most commonly well-differentiated tumors (48%), followed by moderately differentiated (34%) and poorly differentiated (18%). Sah et al.[2] reported squamous cell carcinoma as the most common oral cancer (146, 90.1%), followed by verrucous carcinoma (4, 2.5%), adenoid cystic carcinoma (3, 1.9%), melanomas (3, 1.9%), mucoepidermoid carcinoma (3, 1.9%), basal cell carcinoma (1, 0.6%), adenocarcinoma (1, 0.6%), and spindle cell carcinoma (1, 0.6%).

Correlation of radiological and histopathological TNM staging revealed that of 28 patients staged IVB on imaging, 26 were confirmed IVB and 2 were IVA on histopathology. Of 19 patients staged IVA radiologically, 17 were confirmed IVA, 1 was stage III, and 1 was stage IVB. Vidiri et al.[20] reported that CT accuracy was 82% (K 0.775), with 1 case of downstaging and 8 cases of upstaging.

The sensitivity and specificity of MDCT in evaluating stages IVB, IVA, III, and II buccal malignancy in this study were 96.3% and 94.7%, 85.0% and 95.6%, 80.0% and 94.5%, and 75.0% and 98.2%, respectively. Bux et al.[16] reported overall sensitivity of 86.2%, specificity of 95.3%, and accuracy of 93.6%.

6. Limitations Of The Study

The study had a few limitations:

- No Stage I cases were identified during the study period; therefore, the sensitivity and specificity of MDCT in evaluating Stage I buccal malignancy could not be determined.
- Benign cases were not included, as only biopsy-proven malignant cases underwent CT scanning followed by surgery and histopathological examination.
- Minimally enhancing buccal lesions were difficult to evaluate due to their lower vascularity.

7. Conclusion

As the MDCT findings in the present study correlated well with the histopathological results, with validity measures showing high concordance, it can be concluded that MDCT is an accurate and sensitive modality for the evaluation of buccal malignancy. Therefore, MDCT can be regarded as one of the most reliable diagnostic tools and may be chosen as a primary modality in patients suspected of having buccal malignancy.

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