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Use of Computed Tomography in the Diagnosis of Oral Cavity Carcinoma

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Abstract: ***Background:*** Oral cancer particularly squamous cell carcinoma is a very common problem in Bangladesh. A significant portion of patients present at late stage mostly due to initial symptomless behavior of lesion and lack of awareness. The tumor commonly involves buccal mucosa of mandible and in more advance stage. ***Objectives:*** The study aims to determine the utility of computed tomography in diagnosing oral cavity carcinoma, including the frequency of different types of malignant oral cavity carcinomas. ***Methods and Materials:*** This cross-sectional study was conducted in the Department of Radiology and Imaging at BSMMU from July 2016 to June 2018, enrolling 60 patients with suspected malignant oral cavity carcinoma. Informed written consent was obtained, ensuring ethical standards were maintained throughout the study. Data were collected using a preformed questionnaire and personal file analysis, and were subsequently analyzed using SPSS 23. ***Results:*** The study included 60 patients, with 36.7% aged 65-74 years and 56.7% male. Socio-economically, 73.3% had below-average income. Betel nut/quid chewing was prevalent in 63.33% of cases (p = 0.028), indicating a strong association with oral cancer. Tumor size averaged 4.3 cm, and 53.33% of tumors were in the advanced T4 stage. CT scans showed 70% of lesions were isodense, and the diagnostic accuracy of CT for oral carcinoma was 91.67%, with a sensitivity of 94.87%. ***Conclusion:*** CT plays a crucial role in diagnosing oral cavity carcinoma, particularly in elderly males, with most patients suffering from the disease for an average of three years or more.

Keywords: Oral cavity carcinoma, CT scans, Sensitivity, Malignancy association.

Original Research Article

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Article at a glance:

Study Purpose: *The study examines the role of CT in diagnosing oral cavity carcinoma, particularly squamous cell carcinoma, which is common in Bangladesh, and the challenges of late-stage diagnosis due to symptomless early lesions.*

Key findings: *CT is crucial for diagnosing oral cavity tumors, especially those in the buccal mucosa. Many patients present at advanced stages, highlighting the need for better early detection.*

Newer findings: *The study shows that CT imaging improves diagnostic accuracy by clearly visualizing tumor extent and involvement in surrounding tissues, aiding in better treatment planning.*

Abbreviations: *CT - Computed Tomography, SCC - Squamous Cell Carcinoma, MRI - Magnetic Resonance Imaging, FNAC - Fine Needle Aspiration Cytology, PET - Positron Emission Tomography.*

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INTRODUCTION

Oral cancer is a major neoplasm worldwide and theoretically should be largely preventable if detected at an early stage.[1] Head neck cancers are sixth most common cancer in the world.[2] The oral cavity is one of the ten most frequent sites of cancer internationally, with three peuters of cases affecting people in the developing world, where overall, oral cancer is the third most common cancer after stomach and cervical cancer. An estimated 378,500 new cases of intraoral cancer are diagnosed annually worldwide.[3] There are different type of cancers occur in oral cavity. Among different variety squamous cell carcinoma is the predominant one.[4] Squamous cell carcinoma constitutes 95% cancer of the oral cavity carcinoma.

On gross morphological inspection squamous cell carcinoma most often appears as an ulcerative erythematous lesion with raised indurated irregular margins. Less frequently squamous cell carcinoma is also present as an exophytic or a verrucous lesion. Microscopically squamous cell carcinoma is characterized by cellular changes ranging from local epithelial atypia to generalized dysplasia with invasion of the underlying bone.[5] The artiology appears to be multifactorial and strongly related to lifestyle, mostly habits and diet particularly tobacco alone or in betel chewing and alcohol use). Oral squamous cell carcinoma particularly common in the developing world, mostly in older male. There is concern about an ongoing increase in younger patient and women.

Tumor invade the mandible through the alveolar crest, periodontal space, defects in the cortical bone or cancellous spaces. Once the tumour enters the medullary cavity merit the alveolar nerve provides a ready pathway for perineural spread. It was found that mansion of bone occurs by direct extension of adjacent carcinoma which penetrate the thin and oral layer of the alveolar ridge. Other author also emphasized that attached mucosa is the main potential route of tumour entry because of the lack of the mandible in this area of thedible.[6] The most important indicator of prognosis is the critical stage of the disease. Clinical staging of oral squamous cell carcinoma based on the INM system by UICC (International Union Against Cancer), where T is a measure of tne primary tumour size, N is an estimation of the regional lymph node status and M is a defamation of distant metastasis.

Oral cavity is a challenging area for radiological diagnosis. Soft tissue, glandular tructures and osseous relation are in close proximity and sound understanding of pathological anatomy, local pathology and pathway of disease spread is required. Imaging of oral cavity can be limited by dental amulgum and opposed mucosal surface. computed Tomography is readily accessible and offer faster image acquisition, it usually servesas a first line investigation to broadly distinguish pathological process. In imaging head and neck cancer CI provides a better assessment of cortical bone involvement.[7] cone beam computed tomography has now also become available. The advantage of it is lower boever radiation dose. CT has the advantage over other radiographic technique in that it has an inherent high contrast resolution and tissues that differ in physical density can be distinguished. Computed Tomography is use to assess the size, thickness and location of tumour if it is growing into nearby tissue and if it has spread to lymph nodes in the neck. It can also vesulize the extension of tumour across midline and involvement of tumor beyond the intrinsic mac muscles of tongue. Besides this, it can visualize the involvement of adjacent structures tures, in addition local and distant metastasis are evaluated.[8] Research indicates that the combination of CT with other imaging modalities, such as magnetic resonance imaging (MRI) or positron emission tomography (PET), may enhance diagnostic accuracy.[9] Furthermore, advancements in CT technology, including multi-detector CT (MDCT) and the development of advanced reconstruction techniques, have improved image quality and diagnostic confidence.[10]

However, the use of CT is not without limitations. Radiation exposure remains a concern, especially in populations requiring frequent imaging, such as cancer patients.[11] Additionally, factors such as patient movement and metal artifacts can compromise image quality, potentially leading to misinterpretation.[12] Ongoing studies are exploring strategies to minimize these limitations while maximizing the diagnostic potential of CT in OCC.[13] CT plays a crucial role in the diagnosis and staging of oral cavity carcinoma, significantly impacting clinical management and patient outcomes. Continuous advancements in imaging technology and techniques promise to enhance the utility of CT, paving the way for improved diagnostic accuracy and treatment strategies.[14-16]

OBJECTIVES OF THE STUDY

General Objective

To determine the utility of computed tomography in the diagnosis of oral cavity carcinoma.

Specific Objectives:

To determine the frequency of different types of malignant oral cavity carcinoma.

To determine the frequency of squamous cell carcinoma of oral cavity.

To evaluate the Computed Tomographic findings of localized squamous cell carcinoma of oral cavity. To evaluate the Computed Tomographic findings of metastatic squamous cell carcinoma within oral cavity.

MATERIALS AND METHODS

Study Design

This was a cross-sectional study conducted in the Department of Radiology and Imaging at Bangabandhu Sheikh Mujib Medical University (BSMMU). The study population consisted of patients with clinical suspicion of oral cavity carcinoma, referred from the maxillofacial department, who underwent computed tomography (CT) scans in the Radiology and Imaging department. The study period extended from July 2016 to June 2018, and the sampling method employed was purposive sampling, focusing on selecting cases with clear clinical evidence of suspected oral cavity carcinoma for detailed analysis.

Sampling formula

Sample size was determined by power analysis for a single proportion. Formula for sample size determination for single proportion:

$$n=\frac{[Z_\beta\sqrt{P(1-P)}+Z_\alpha\sqrt{P_0(1-P_0)}]^2}{(P-P_0)^2}$$

P= Proportion under alternative hypothesis (H_2) that is proposed to be detected.

P_0 =Proportion under null hypothesis (H0).

It was hypothesized that in evaluation oral cavity carcinomas CT will be sensitive 93% of pereater. The sample size was calculated for a power level of 90% (where, Z=1.28), an error of 0.05 (95% confidence level, where 2-1.96, two tail).

Here,

n= Sample size

Z_β=1.28

$Z\alpha$.96

P= 93%-0.93

P0= 79%-0.79

$$n=\frac{[1.28\sqrt{0.93(1-0.93)}+1.96\sqrt{0.79(1-0.79)}]^2}{(0.93-0.79)^2}$$

53.2 (estimated sample size)

= In addition, 7 patients were added considering non-response rate. Therefore, target sample size was 60.

Data collection

Aims and objectives of the study were explained to the patient. The informed written consent was taken from all the patient and information about patient and clinical finding were obtained in the pre-structured data collection format (appendix-B). CT examination was performed using a 64 slice multidetector Hitachi Scenaria using standard technical parameters. The scans were performed with the patient's supine with head first, using the following parameters: slice collimation 4x1; tube voltage, 120 kV; effective mAs, 150; slice thickness 1 mm; reconstruction section thickness 1.5 mm gantry rotation time 0.8 s; field of view (FOV) 35-50 cm. At first, precontrast CT images were obtained. Successively postcontrast images were achieved after the intravenous administration of 110 ml of iodinated non-ionic contrast material (lomeron 300 mg. Bracco Spa, Milan Italy) at a flow rate of 3 ml/s. Following this contrast injection, the pathological tissue often manifested an increase of density which facilitates distinction between normal and pathological tissue.

Inclusion criteria

All patient attending to radiology department to undergo CT with clinical evidence of suspected malignant oral cavity lesion.

Exclusion criteria

Presence of metallic artifacts in the images that could interfere with pathological interpretation e.g. crown, Preoperative treatments with radiotherapy and/or chemotherapy, Patients who are refused CT.

Statistical analysis

All the data were checked and edited after collection. Then data were entered in SPSS (Statistical Package for social Science) 23 for Windows 10 program version. An analysis plan was developed keeping the objectives of the study in mind. Frequency distribution and normal distribution of all continuous variables were calculated and expressed a Mean ± SD. Further association were done by chi-square test. Sensitivity, specificity positive and negative predictive value of CT against the findings from histopathology were calculated by using standard formula. In all cases p value <.05 was considered significant.

RESULTS

Table 1: Distribution of Patients According to Age, Gender, and Socio-Economic Condition (n=60)

Age groups	Frequency	Percentage (%)
35-44	4	6.7
45-54	8	13.3
55-64	21	35.0
65-74	22	36.7
75-84	5	8.3
Gender		
Male	34	56.7
Female	26	43.3
Socio-Economic Condition		
Below average	44	73.3
Average	13	21.7
Above average	3	5.0

Table 1 outlines the demographic distribution of 60 patients based on age, gender, and socio-economic condition. The most represented age group is 65-74 years, comprising 36.7% of the patients, followed closely by the 55-64 age group with 35%. Males make up the majority of the study population, accounting for 56.7%, while females represent 43.3%. In terms of socio-economic status, 73.3% of the patients fall below average income, while 21.7% are of average economic standing, and only a small fraction (5%) is above average.

Table 2: Risk factor analysis of oral cavity cancer (n=60)

Risk factors		Oral cavity malignancy (n=60)		X^2
		No	%	p-value
Betel nut/quid	Chews	38	63.33	4.8,0.028
	Does not chew	22	36.67	
Smoking	Smoker	39	65.00	1.87,0.172
	Non-smoker	21	35.00	

Table 2 analyzes the association between risk factors and the occurrence of oral cavity malignancy in a population of 60 patients. Among the patients, 63.33% chewed betel nut/quid, which is statistically significant ($p = 0.028$), indicating a strong correlation with oral cavity cancer. In contrast, 36.67% did not chew betel nut/quid. Regarding smoking, 65% of the patients were smokers, while 35% were non-smokers. However, smoking was not statistically significant as a risk factor ($p = 0.172$).

Table 3: Size and duration of the tumors (n=60)

Tumor characteristics	n/(mean±SD)	%/range
Size of tumor (cm)	4.3 ± 1.5	0.50 - 7.50
Duration of tumor (years)	3.3 ± 1.99	0.42 - 8.00

Table 3 presents the characteristics of tumors in 60 patients, focusing on tumor size and duration. The average size of the tumors is 4.3 cm, with a standard deviation of 1.5 cm, and the sizes range from 0.50 cm to 7.50 cm. The duration of tumors spans from 0.42 to 8 years, with a mean duration of 3.3 years and a standard deviation of 1.99 years.

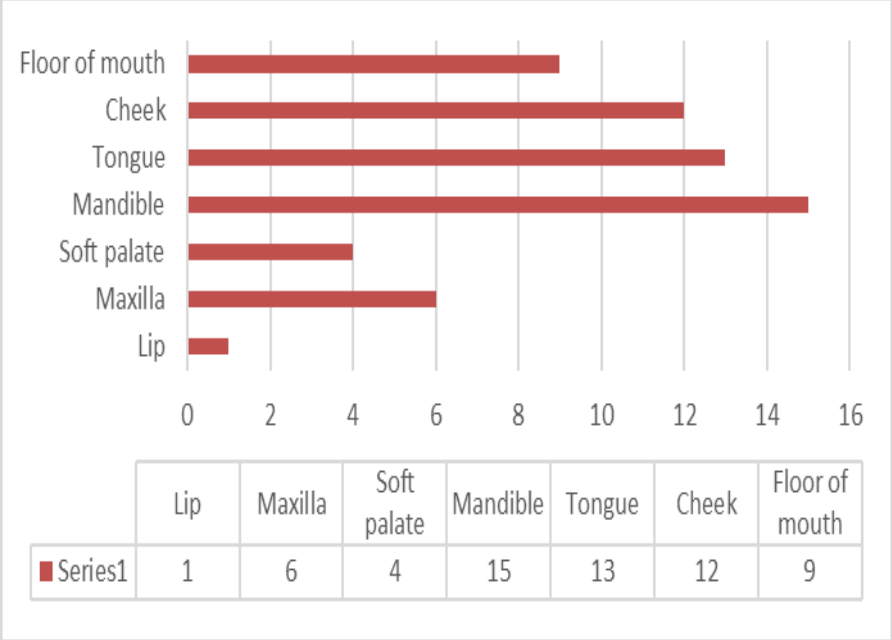

Figure 1: Site of Origin of Tumor (n=60)

Figure 1 shows the distribution of tumor sites in 60 patients diagnosed with oral cavity malignancy. The most common site of origin was the mandible, with 25% of the tumors originating there. The tongue and cheek followed, with 21.67% and 20% of the cases, respectively. Tumors originating from the floor of the mouth accounted for 15%, while the maxilla and soft palate contributed 10% and 6.67%, respectively. The lip was the least common site, with only 1.67% of the tumors originating there.

Table 4: Characteristics of Oral Cavity Carcinoma in CT (n=60)

Characteristics of lesion	Frequency	Percentage (%)
Hypodense	6	10.00
Isodense	42	70.00
Hyperdense	3	5.00
Mixed density	9	15.00

Table 4 summarizes the CT scan characteristics of oral cavity carcinoma in a group of 60 patients. The majority of the lesions (70%) were isodense, indicating that most tumors had a similar density to surrounding tissues. Mixed density lesions, where both hypodense and hyperdense areas coexist, were observed in 15% of cases. Hypodense lesions, appearing less dense than surrounding tissues, accounted for 10%, while hyperdense lesions, which are denser than the surrounding tissues, were seen in only 5% of patients.

Table 5: Contrast enhancement of Oral Cavity Carcinoma in CT (n=60)

Contrast enhancement	Frequency	Percentage (%)
Homogeneous	48	80.00
Heterogeneous	12	20.00

Table 5 presents the contrast enhancement patterns of oral cavity carcinoma in CT scans among 60 patients. The majority of cases (80%) showed homogeneous enhancement, where the contrast agent was evenly distributed throughout the lesion, indicating uniform tissue characteristics. In contrast, 20% of the lesions displayed heterogeneous enhancement, suggesting variable tissue composition or irregular vascularization

Table 6: Staging of the tumors (n=60)

Tumor stages	Frequency	Percentages (%)
T1	5	8.33
T2	10	16.67
T3	13	21.67
T4	32	53.33

Table 6 outlines the distribution of tumor stages in 60 patients with oral cavity carcinoma. The majority of patients (53.33%) presented with advanced-stage tumors classified as T4, indicating the most severe stage with significant tumor invasion. Tumors in the T3 stage comprised 21.67% of cases, while 16.67% of the patients had T2-stage tumors. Only 8.33% of the tumors were in the early T1 stage.

Table 7: Nodal Involvement by The Tumors (n=60)

Nodal involvement	Frequency	Percentages (%)
N0	27	45.00
N1	15	25.00
N2	17	28.33
N3	1	1.67

Table 7 presents the nodal involvement in 60 patients with oral cavity carcinoma. Nearly half of the patients (45%) showed no lymph node involvement (N0). However, 28.33% had moderate nodal involvement classified as N2, and 25% had early nodal involvement (N1). A small fraction (1.67%) of patients presented with extensive nodal metastasis (N3).

Table 8. Diagnostic accuracy of Computed Tomography in assessing Oral Carcinoma

Validity tests	Formula	Percentage
Sensitivity	TP/(TP+FN) x 100	94.87
Specificity	TN/(TN+FP) x 100	85.71
Accuracy	(TP-TN)/ (TP+FN+TN+FP) x 100	91.67
Positive predictive value	TP/ (TP-FP) x 100	92.50
Negative predictive value	TN/ (TN+FN) x 100	90.00

TP* true positive, FP** false positive, FN*** false negative, TN**** true negative

Table 8 outlines the diagnostic accuracy of computed tomography (CT) in assessing oral carcinoma among 60 patients. The sensitivity, indicating the ability of CT to correctly identify patients with the disease, is 94.87%. The specificity, reflecting CT's ability to correctly identify those without the disease, is 85.71%.

Overall diagnostic accuracy is 91.67%, showing that CT performs well in correctly diagnosing both positive and negative cases. The positive predictive value (92.50%) indicates that most positive CT results are true positives, while the negative predictive value (90.00%) suggests that most negative results are true negatives.

DISCUSSION

The study investigated the clinical, radiological, and pathological features of oral cavity carcinoma in 60 patients. Our findings indicated that the majority of patients (53.33%) presented with advanced-stage tumors (T4), which aligns with the trend observed in similar studies showing that patients often present with late-stage malignancies due to delayed diagnosis and treatment. A study by Sharma et al. found that 60% of patients with oral cavity carcinoma also presented with advanced-stage tumors, emphasizing the aggressive nature of the disease and the importance of early detection.[17] In our study, 45% of patients showed no lymph node involvement (N0), while 28.33% and 25% had N2

and N1 stages, respectively. A similar study by Chaturvedi et al. reported that lymph node involvement is a significant prognostic factor in oral cancer, with N2 being present in 30% of their cohort, correlating with our findings.[18] Lymph node metastasis significantly impacts the prognosis and survival rates of oral cavity carcinoma patients, highlighting the need for regular lymph node assessment in clinical practice.[19]

The majority of tumors (70%) were found to be isodense in CT scans, while 15% had mixed density, and 10% were hypodense. This is consistent with findings from the study by Parmar et al., who reported that 68% of oral carcinoma lesions were isodense, indicating that the tumor density on imaging closely matches that of surrounding tissues, making early detection more challenging.[20] The presence of mixed-density lesions was also noted to be associated with more aggressive tumor behavior.[21] In terms of contrast enhancement patterns, 80% of our patients exhibited homogeneous enhancement, while 20% had heterogeneous enhancement on CT scans. A study by Narayanan et al. showed similar results, with 75% of tumors exhibiting homogeneous enhancement, which suggests that tumors with uniform enhancement often have well-differentiated histology.[22] On the other hand, heterogeneous enhancement is typically seen in more advanced or poorly differentiated tumors.[23]

Betel nut/quid chewing was found to be a statistically significant risk factor for oral cavity cancer in our study, with 63.33% of patients being chewers ($p = 0.028$). This is in line with the findings of Warnakulasuriya et al., who reported that betel nut chewing is a well-established carcinogen for oral cavity malignancies, especially in South Asian populations, where the habit is prevalent.[24] Smoking, although prevalent in 65% of our patients, was not statistically significant as a risk factor ($p = 0.172$). Similar studies have shown a significant association between smoking and oral cancer, particularly in combination with other risk factors like alcohol consumption and betel nut chewing.[25] Tumor size in our study ranged from 0.50 cm to 7.50 cm, with an average size of 4.3 cm. This is comparable to a study by Dantas et al., who reported an average tumor size of 4.5 cm in oral cavity carcinoma patients.[26] Larger tumor size is often correlated with poorer prognosis and increased likelihood of metastasis.[27, 28]

CONCLUSION

Role of CT is well established in diagnosis of head and neck tumors and it is useful in detecting metastasis. The study was focused to assess the role of CT in diagnosis of oral cavity carcinoma. In this study, it is revealed that elderly male patients are more sufferer from oral cavity carcinoma. Most of them suffers at an average age of 3 years or more.

Limitations

The study had several limitations. It employed a cross-sectional design, did not evaluate factors influencing carcinoma, and did not assess risk factors or establish associations, which were beyond the scope of the study.

Recommendations

It is recommended that CT scans be performed in suspected cases of oral carcinoma, as well as prior to any surgical procedures or radiotherapy.

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