Comparative analysis of preoperative CECT scan with histopathology in oral cavity malignancies

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Background:
Oral cavity carcinomas carries significant morbidity and mortality particularly among the young male population in the developing world due to habitual usage of tobacco and betel quid. The physical examination allows for the visual assessment of the superficial lesions, however, the extent of the deep structure could not be done. The evaluation of the spread of these tumours to the adjacent structures is crucial for the diagnosis, staging and planning for appropriate treatment strategy. Hence cross-sectional imaging like MDCT and MRI plays a vital role in diagnosis, in assessing the spread and staging of these tumours.
Objectives:
The primary objective of this subject is to determine the comparison of CECT in the detection of the primary T stage and nodal involvement of primary oral cavity tumours with histopathlogical findings.
Methods:
This study is a restrospective, analytical observational study carried out on 42 patients diagnosed with carcinoma of the oral cavity in our tertiary care hospital for 6 months. MDCT plain and contrast were performed preoperatively for all patients having oral cavity carcinomas to allow for better visualization and characterisation of primary lesions and assess the nodal morphology and invasion of vascular structures. Data from the intraoperative surgical and histopathological findings were collected and compiled and finally correlated with the MDCT findings.
Results:
IBM SPSS (Version 26.0) (Released 2020, IBM Corp. New York, US) was used for statistical analysis. Totally fourty-two patients were included in the study of which 61% are females and 39% are males. The commonest age group of presentation was between 50 to 60 years. The t stage of the primary tumor in our study was identified with a 93% accuracy by MDCT. Sensitivity, Specificity, and accuracy of MDCT in identifying osseous erosion were 100%, 80% and 87% respectively. Node involvement by the tumor was identified by MDCT with a sensitivity of 89%, specificity of 97 % and accuracy of 97%.
Conclusion:
Preoperative assessment by multidetector computed tomography is very crucial for the accurate staging of primary oral cavity tumours which helps the treating physicians in establishing the appropriate treatment strategy in the management of these patients.

Keywords: Oral cavity malignancy, MDCT, T stage, Nodal involvement, Bone erosion.

Introduction

Oral cavity carcinomas carries significant morbidity and mortality particularly among the young male population in the developing world due to habitual usage of tobacco and betel quid [1]. The risk factors that have been implicated in the development of oral cavity tumours are tobacco usage and consumption of alcohol. Squamous cell carcinoma accounts for the majority of carcinoma affecting this region [1]. Human papillomavirus (HPV) infection is also a known causative agent for the development of the papillary type of SCC accounting for about 25 percent of patients [3,4].

The clinical presentation, spread and prognosis of these carcinomas greatly depend on the site from which they originate and it plays a vital role in assessing the tumor characteristics such as tumor spread and nodal drainage [2]. The anatomy of this region is complex and therefore intricate knowledge about anatomy is required to distinguish lesions based on their site of origin.

The physical examination allows for the visual assessment of the superficial lesions, however, the extension into the deep structure cannot be assessed. The evaluation of the spread and depth of these tumours to the adjacent structures is crucial

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for the diagnosis, staging and planning for appropriate treatment strategy. Hence crosssectional imaging like MDCT and MRI plays a vital role in the diagnosis of these carcinomas as well as in assessing the spread of these tumours [1,2].

Materials and methods

After obtaining approval from the Institutional Ethical Committee of Karpaga Vinayaga Medical College & Research Centre, the study was carried out in the Department of Radiodiagnosis over 6 months. Patients with oral cavity carcinoma who were ever evaluated with plain and contrast-enhanced computed tomography and had undergone surgery in our institution were included in the study. The exclusion criteria included patients with a previous history of radiation to the skull base and neck, patients who have undergone any major head and neck surgeries except for dental procedures and patients with infective conditions. The patients were explained the objectives of this study and informed written consent was taken along with their signature.

Plain and contrast CT were performed preoperatively for all patients of the study group having oral cavity carcinomas using CT neck protocol, the patients were scanned from the skull base to the aortic arch. Contrast was injected intravenously at the dose of 1-1.5 ml/kg to allow for better visualization and characterisation of lesions, to assess the nodal morphology and invasion of vascular structures. The CT parameters which were assessed and documented are the extent and enhancement pattern of the primary lesion, soft tissue extension, osseous involvement and the size, shape and morphology of the cervical lymph nodes. TNM staging of primary oral cavity tumours based on imaging was given. Data from the intraoperative surgical and histopathological findings were collected and compiled.

Results

IBM SPSS (Version 26.0) (Released 2020, IBM Corp. New York, US) was used for statistical analysis. Descriptive statistics are used for T and N staging and were expressed in terms of percentages. A 2 x 2 table was constructed to determine validity measures (sensitivity, specificity, PPV, NPV and accuracy) for MDCT for the detection of T and N stage in primary oral cavity carcinomas. The threshold for statistical significance was set at 0.05. The study was conducted on 42 patients who presented to our institution with signs and symptoms of primary oral cavity tumours. The commonest age group of presentation was around 50-60 years. Females (61.44%) were more commonly affected than males (39%) in the present study. The habit of chewing betel quid and smoking (32.53%) is noticed in most of the patients in our study followed by tobacco chewing (22.6%) (Figure 1).
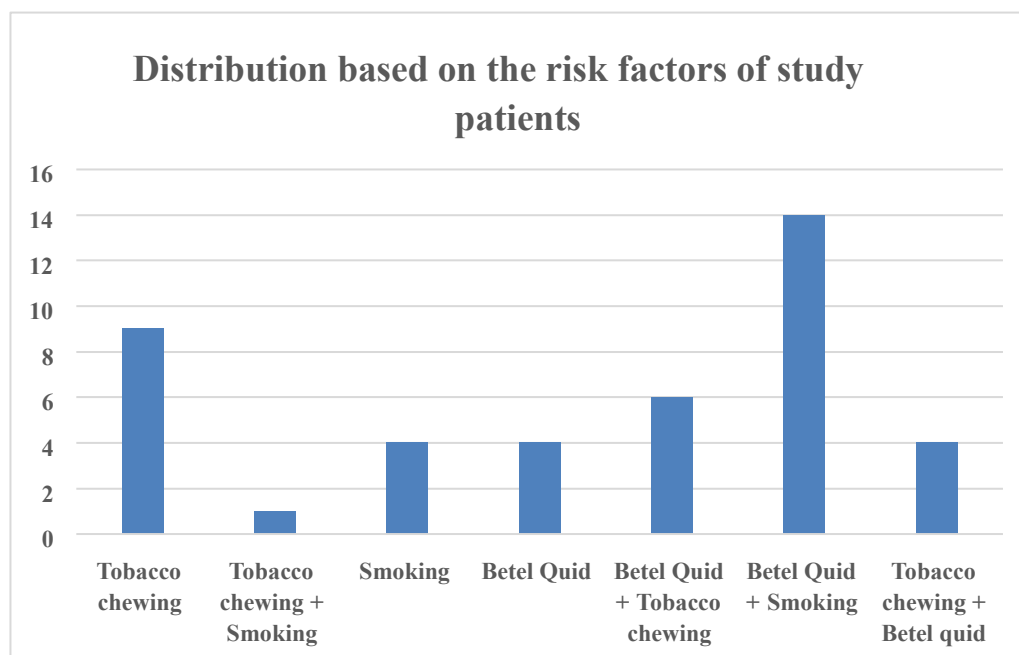

Figure 1. Distribution based on the risk factors of study patients

In our study, the most common site for malignant was in the buccal mucosa (37.34%) followed by the lateral border of the tongue and retromolar trigone which contributed to 22.89% and 13.25% respectively (Figure 2).
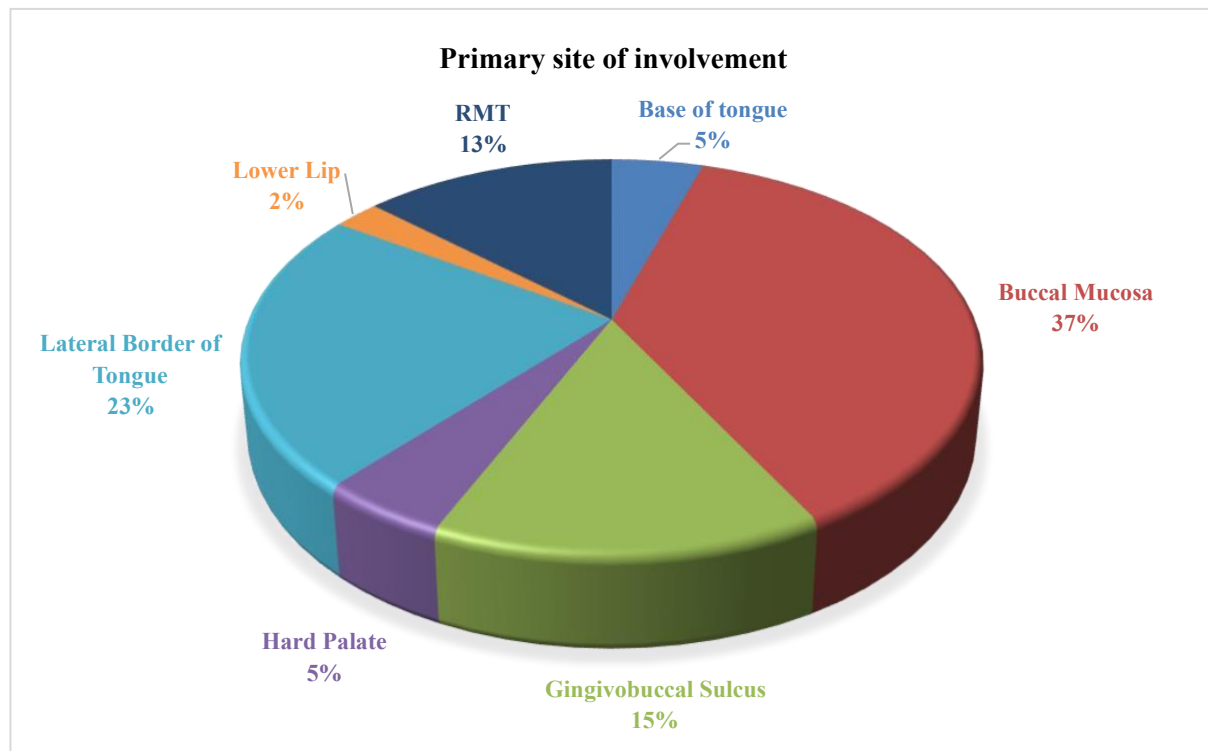
Figure 2. Pie chart showing the location of oral cavity cancers in our study.

In our study, all the patients were diagnosed with squamous cell carcinoma (SCC) with different degrees of differentiation while well-differentiated squamous cell carcinoma was predominant.

Out of the total 42 cases in our study, the majority of patients had T4 lesions (48%) at the time of presentation, followed by T2 lesions (29%) based on MDCT (Figure 3). In comparison to the histopathology, 36% of them had T4 lesions on MDCT followed by 30% of them having T2 lesions (Figure 4).
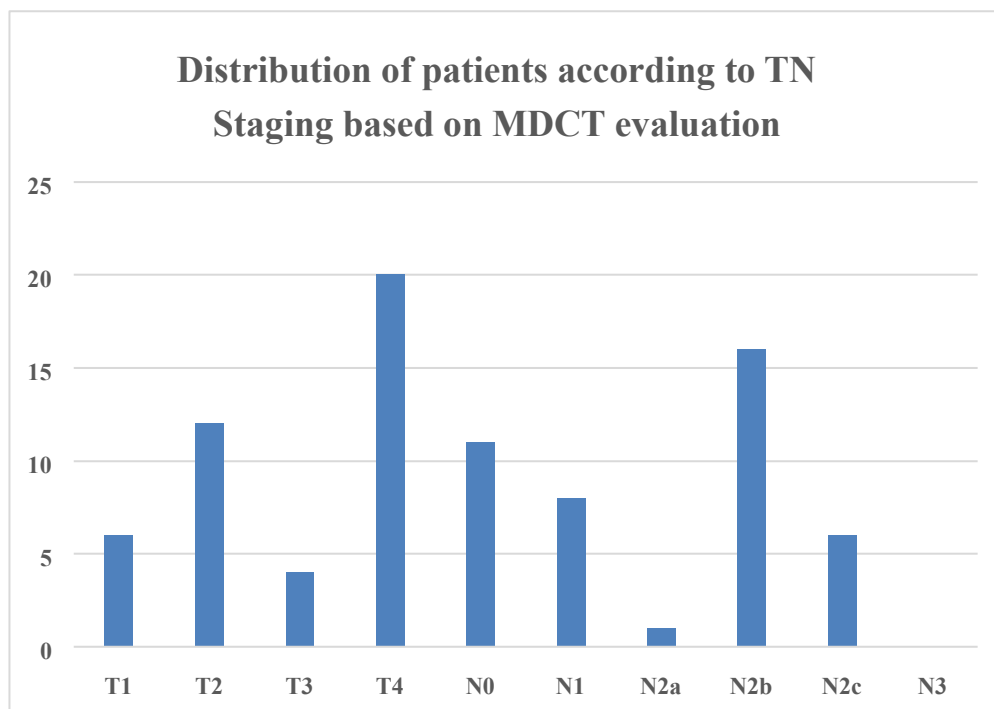
Figure 3. Distribution of patients according to TN Staging based on MDCT evaluation
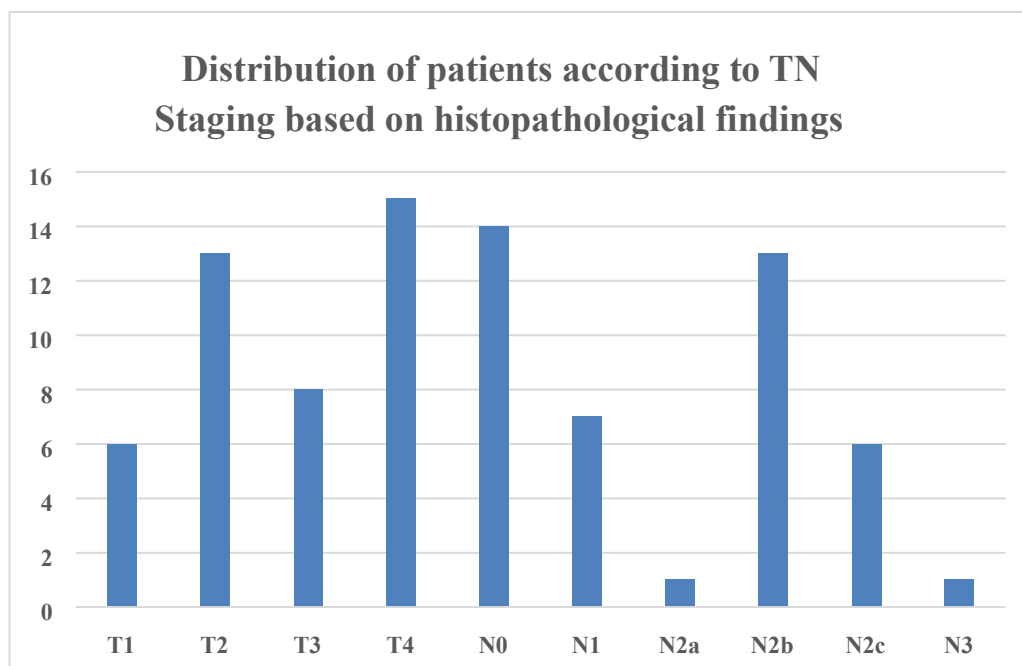
Figure 4. Distribution of patients according to TN Staging based on histopathological findings

Nodal status according to the MDCT were N1 (19%), N2a (2%), N2b (38%), N2c (14.25%).No evidence of the N3 nodal stage on MDCT (Figure 3). Nodal status based on HPE were as follows N1 (17%), N2a (2%), N2b

(31%), N2c (14%) and N3 (2%) (Figure 4). Node negativity was observed in 26% of patients on MDCT while for HPE it was found to be 33%

The statistical analysis and sensitivity, specificity, PPV, NPV and accuracy for each of the T stages are shown in Table 1,2.

		Histopathological T staging				Total	Kappa value
		T1	T2	T3	T4		**81.2%**
	T1	6	0	0	0	6	
Radiological T staging	T2	0	12	0	0	12	**(71.0%-91.4)**
	T3	0	0	4	0	4	
	T4	0	1	4	15	20	
Total		6	13	8	15	42	

Table 1: Association between radiological and histopathological Tumor (T) staging.

Validity Indicators	MDCT			
	T1	T2	T3	T4
Sensitivity (%)	100%	92.31%	47%	100%
Specificity (%)	100%	100%	100%	79.63%
Positive predictive value (PPV) (%)	100%	100%	100%	34.94%
Negative predictive value (NPV) (%)	100%	96.61%	88%	100%
Accuracy (%)	**100%**	**97.59%**	**89.16%**	**86.75%**

Table 2: Analysis for estimating the validity measures of MDCT vs Histopathology for identifying patients with different tumor stages.

The overall sensitivity and specificity of MDCT in our study in the detection of primary tumour size and soft tissue involvement (T1, T2, T3 and T4) of oral cavity tumours were 86.74% and 94.90% respectively with an overall accuracy of 93% (Table 3).

Validity Indicators	MDCT (%)
Sensitivity (%)	86.74
Specificity (%)	94.90
Positive predictive value (PPV) (%)	83.73
Negative predictive value (NPV) (%)	96.15
Accuracy (%)	93.37

Table 3: Overall Diagnostic Validity of MDCT Findings in Evaluation of size of the Tumour and involvement of Adjacent Structures of Oral Cavity Carcinoma Individual validity indicators of each nodal stage are shown in Table 4,5.

		Histopathological N staging						Total	Kappa value
		N0	N1	N2a	N2b	N2c	N3		**85.4% (76.5-94.4)**
Radiological N staging	N0	11	0	0	0	0	0	11	
	N1	0	7	0	1	0	0	08	
	N2a	0	0	01	0	0	0	01	
	N2b	3	0	0	12	0	1	16	
	N2c	0	0	0	0	6	0	6	
	N3	0	0	0	0	0	0	0	
Total		14	07	01	13	6	1	42	

Table 4: Association between radiological and histopathological Nodal (N) staging.

Validity Indicators	MDCT					
	N0	N1	N2a	N2b	N2c	N3
Sensitivity (%)	77.78%	100%	100%	96%	100%	0%
Specificity (%)	100%	98.53%	100%	86.21%	100%	100%
Positive predictive value (PPV) (%)	100%	93.75%	100%	75%	100%	0%
Negative predictive value (NPV) (%)	90.32%	100%	100%	98%	100%	97.6%
Accuracy (%)	**77.78%**	**98.80%**	**100%**	**89.16%**	**100%**	**97.6%**

Table 5: Analysis for estimating the validity measures of MDCT vs Histopathology for identifying patients with different nodal stages.

The overall sensitivity of MDCT in our study for nodal involvement was found to be 89% and overall specificity was found to be 97%. Based on our study data, MDCT has an overall accuracy of 96.80% in identifying the patients with cervical node involvement table (Table 6).

Validity Indicators	MDCT (%)
Sensitivity (%)	89.15
Specificity (%)	97.45
Positive predictive value (PPV) (%)	78.12
Negative predictive value (NPV) (%)	97.65
Accuracy (%)	96.80

Table 6: Overall Diagnostic Validity of MDCT in detection of Lymph Nodes involvement or Nodal metastasis of Oral Cavity Carcinoma

Discussion

Oral cavity carcinomas are the most common form of cancer in the developing world particularly affecting the young male population due to the habitual usage of tobacco and betel nut chewing. The clinical presentation, the spread and the prognosis of these carcinomas depend mainly on the site from which they originate.

Direct assessment of these carcinomas by clinical examination is limited, hence cross-sectional imaging modalities such as CT, MRI and nuclear imaging such as scintigraphy play an important role in the evaluation of these carcinomas.

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MDCT is preferred over other imaging modalities for the evaluation of oral malignant neoplasms since it accurately depicts the tumour extent, soft tissue extension, bone erosions and lymph node involvement [14]. MDCT by puffed-cheek technique provide a more clearer and detailed evaluation of mucosal surfaces of the oral cavity. It helps in the detection of small primary tumours and to delineate tumor margins better than conventional CT [16]. In the case of carcinoma tongue, the protrusion technique helps in the evaluation of lesions, especially in the tip and ventrolateral marginal region and rules out extension into the floor of the mouth [16].

This study was carried out in 83 patients with a common age group of presentation between 51 to 60 years (37.3%) with a female (61%) preponderance. The most common site of malignancy in our study was buccal mucosa (37.34%) (Figure 5) followed by the lateral border of the tongue (22.89%) (Figure 6) and retromolar trigone (13.25%) (Figure 7) which was probably due to the method of usage of tobacco in which tobacco is usually stuffed in the region of the gingivobuccal sulcus.
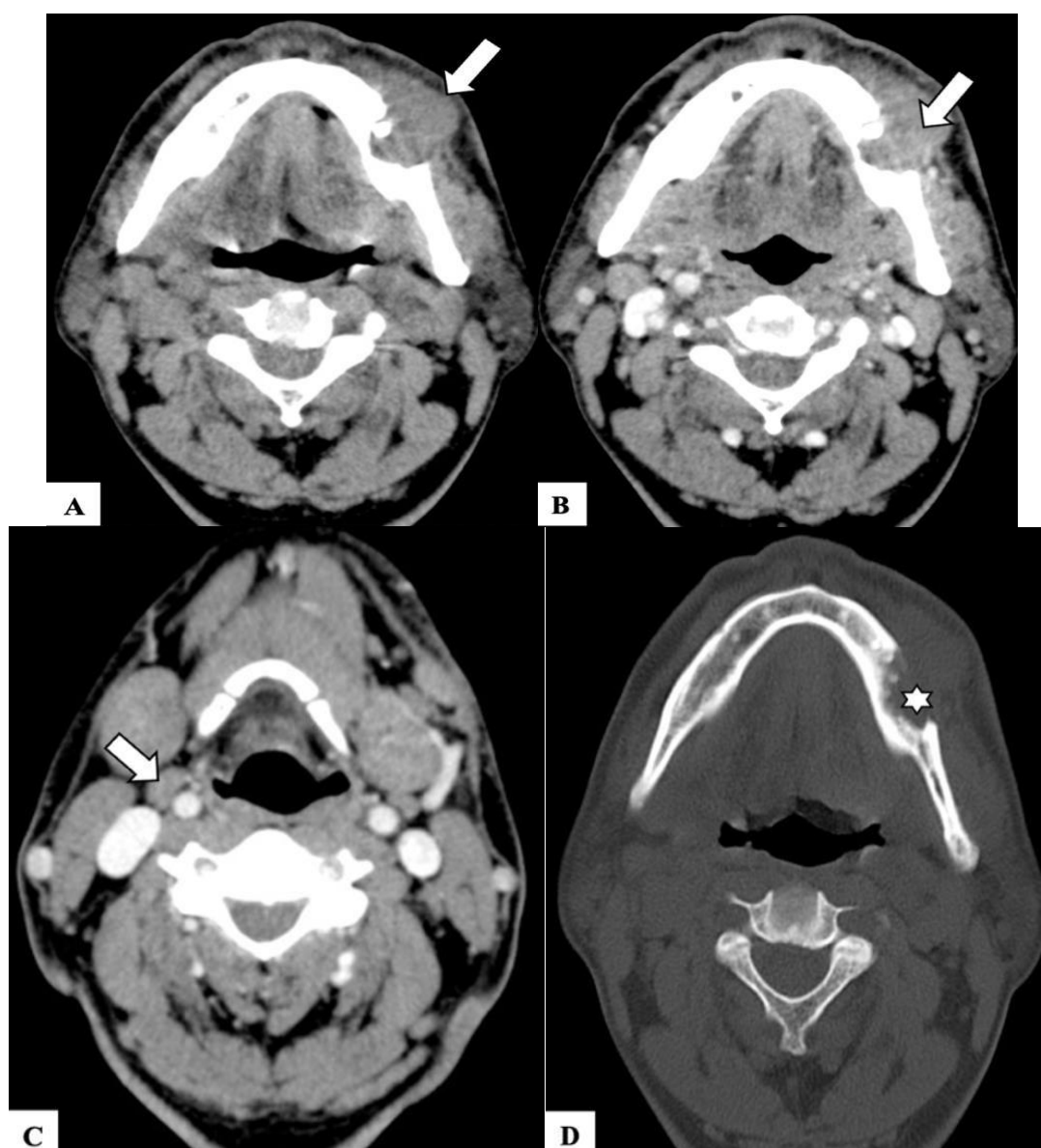

Figure 5. Axial plain (A) and CECT (B) images showing a heterogeneously enhancing mass in the left gingiva-buccal sulcus. CECT axial images (C) shows bilateral sub-centimetric cervical lymph nodes. Bone window (D) shows an erosion and destruction of left body of mandible (C, D).
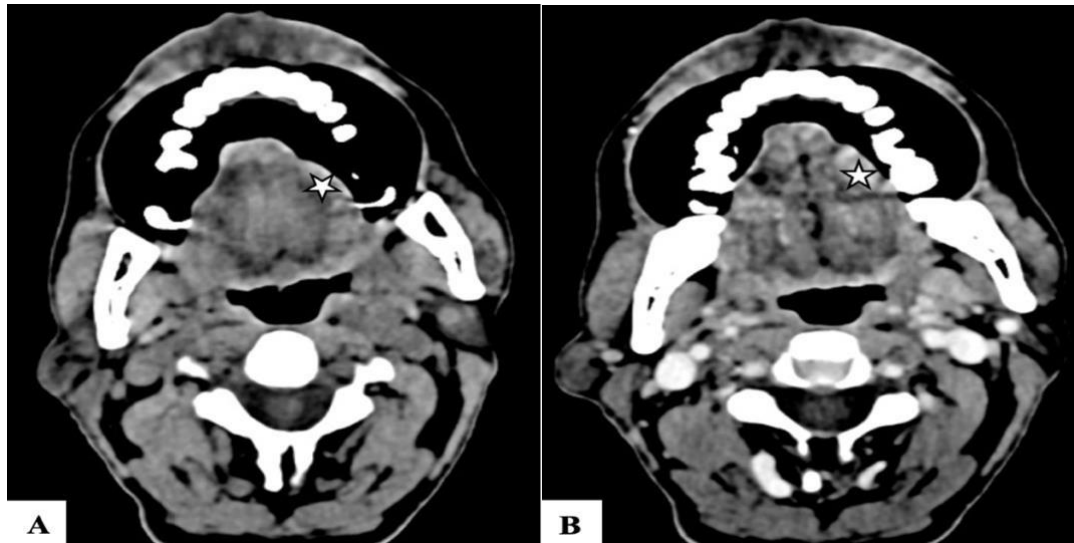
Figure 6. Axial plain (A) and CECT (B) images shows a heterogeneously enhancing soft tissue density lesion in the left lateral border of tongue (asterisk) with bilateral sub centimetric cervical lymph nodes.
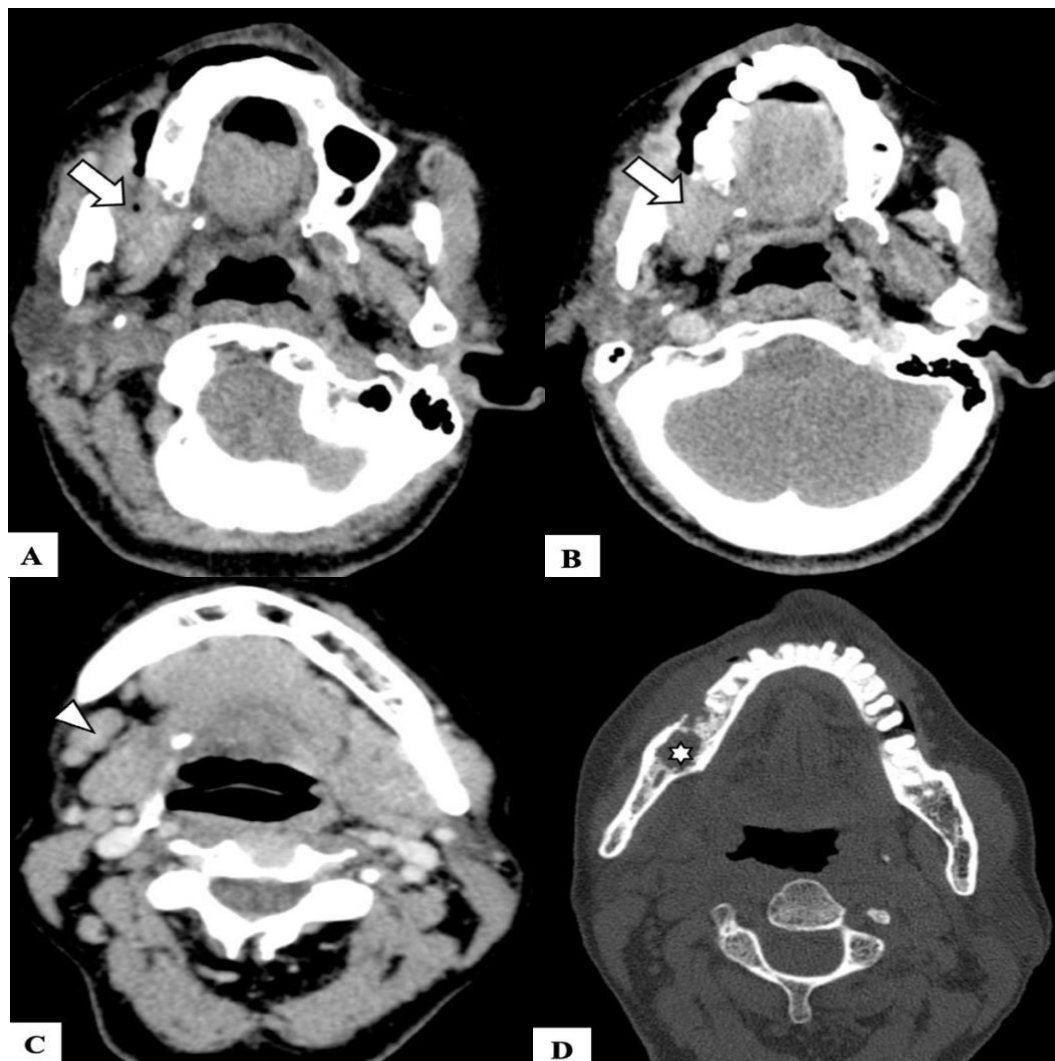
Figure 7 . Axial (A) and CECT (B, C) and bone window (D) axial images showing enhancing lesion in the right retromolar trigone buccal mucosa (arrows) with destruction of the mandible (asterisks) and cervical lymphadenopathy (arrow head).

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In our study, all the patients were diagnosed with squamous cell carcinoma (SCC) with different degrees of differentiation with well-differentiated squamous cell carcinoma being the predominant one as evidenced by the previous studies.

The overall sensitivity and specificity of MDCT in the detection of primary tumour size and soft tissue involvement (T1, T2, T3 and T4) of oral cavity tumours in our study were 86.74% and 94.90% respectively. The sensitivity in our study was higher compared to the other study by Dammann F. et al and specificity was comparable to the previous study [8]. The sensitivity of MDCT in assessing T1 and T4 conditions was almost 100% whereas higher specificities were reported in T1, T2 and T3 conditions.T4 condition is found to have a lower specificity of about 79.7% in our study.

In our study, MDCT accuracy of T1, T2, T3 and T4 conditions were identified at 100%, 97.6%, 88% and 86.7% respectively.

The overall accuracy of MDCT of the head and neck in the detection of primary tumour size and soft tissue involvement was 93.37% whereas surgical accuracy was 80.12%.

The reported incidence varied between 12% to 88% for bone involvement by tumours in the oral cavity. Osseous involvement is best evaluated with MDCT. Features of bone involvement in MDCT by tumours are bone erosion, periosteal reaction, and fractures of the involved bone [11,12]. The bones most commonly affected by oral cavity lesions are the mandible and the maxilla [15,17].

In our study, bone invasion by MDCT was confirmed in 21 cases. The bone involvement was noted in 21 patients on MDCT and 8patients on histopathology.

In our study the sensitivity and specificity of MDCT in detecting bone involvement were found to be 100% and 80% which was comparable to the study done by Nikunj C. Desai [1]. The sensitivity in their study in the detection of bone erosion and involvement was found to be 98%.

In our study, MDCT had an accuracy of 86.75% for detecting osseous involvement by tumours while for surgical findings it was around 84.43%.

Lymph node involvement
The head and neck structures have very good lymphatic drainage. About a quarter of the entire lymph nodes in the human body are present in this region. The head and neck structures drain into seven levels of cervical lymph node stations [5].

The most common initial presentation of most oral cavity squamous cell carcinomas are palpable neck mass that represents the involvement of the cervical group of lymph nodes.

The major route of the spread of oral malignancy is lymphatic metastasis which is the major reason for treatment failure in oral carcinoma.

Around more than half of patients with oral cavity carcinomas present with palpable cervical lymph nodes due to metastases [18]. The base of the tongue carcinomas is more associated with regional lymph node metastasis, followed by tumours of the floor of the mouth, tonsillar fossa, soft palate and oropharyngeal wall.

The imaging assessment of cervical lymph node involvement in patients with oral cavity carcinoma includes lymph node size determination, node morphology, and margination. The most valuable pathognomonic imaging features of involved lymph nodes are large lymph node size and the presence of central necrosis [13,18]

Metastasis to the cervical nodal chain by oral cavity carcinomas is the single most important prognostic factor in predicting the survival rate [6]. The presence of a single node involvement reduces the patient's survival rate by half [13,18].

Nodal positivity was observed in 67.46% of the patients with primary oral cavity tumours. The majority of the patients had N2b condition on presentation which was diagnosed on MDCT with a sensitivity of 96%, specificity of 86.2% and accuracy of 89%.

The sensitivity of MDCT in our study for nodal involvement in N1, N2a and N2c conditions was found to be 100% and specificity was found higher in N1, N2a, N2b and N2c conditions.

In our study, there were zero patients reported with N3 conditions on MDCT but histopathological there were one positive cases that might have occurred due to a chance.

MDCT revealed 11 lymph node-negative cases, which results in a sensitivity of 77.78% and specificity of 100% for detecting lymph node involvement. Thirty one patients were found to have nodal involvement in MDCT and it had a sensitivity, specificity and accuracy of 89.15%, 97.45% and 96.8% which was in line with the previous study published by Curtin HD and Adams S et al. which had a broad range of sensitivities ranging from 60% – 90% and specificities ranging from 40% to 98% [9,10].

Based on our study data, MDCT has an accuracy of 96.80% in identifying patients with cervical node involvement.

The sensitivity and specificity of our study for identifying lymph node involvement are found to be on the higher side. Positive predictive value and Negative predictive value were 78.12% and 97.65% respectively, which implies that MDCT can be used as the imaging modality of choice for the detection of lymph node involvement. Its accuracy however in detecting the positive cases is more than that of the negative cases.

MDCT accuracy for the detection of metastatic lymph nodes was found to be 96.8%, which in turn implies that MDCT can able to provide us with the proper

diagnosis 97% of the time. This study's results were in line with the previous studies which state that cross-sectional imaging is the optimal modality for the evaluation of cervical lymph nodes to rule out metastasis [7].

Conclusion

Multidetector computed tomography has the highest sensitivity, specificity and accuracy in the assessment of the tumour size, surrounding soft tissue and osseous involvement (T staging) in carcinomas of the oral cavity. Evaluation of cervical lymph nodes by MDCT has a higher accuracy for detection of metastasis than intraoperative assessment. Thus, multidetector computed tomography staging of oral cavity tumours is very crucial for the proper staging which helps the surgeon in establishing the appropriate treatment strategy in the management of patients with oral cavity carcinoma.

Additional Information
Disclosures
Human subjects: Consent was obtained or waived by all participants in this study. Karpaga Vinayaga Institute of Medical Sciences & Research centre Institutional Ethics Committee issued approval. The Institutional Ethics Committee in its meeting held, has approved the following research work proposed to be carried out at Karpaga Vinayaga Institute of Medical Sciences & Research centre. This approval has been granted on the assumption that the proposed research work will be carried out following the ethical guidelines prescribed by the Central Ethics Committee on Human Research (C.E.C.H.R).

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.
Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work.

Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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