Original Article

Neck Node Metastasis in Oral Squamous Cell Carcinoma: A Clinicopathological Analysis

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ABSTRACT

Objective: To identify the incidence of metastases from lymph nodes and its association with several clinicopathological variables.

Study Design: Retrospective cohort study

Place and Duration of Study: This study was conducted at the oral and maxillofacial surgery department of Liaquat University of Medical and Health Science in Jamshoro carried out this study in October 2024 and August 2025.

Methods: The study incorporated 117 cases of OSCC that were reported to our institute in total. All OSCC cases with biopsy evidence were included in the research. Data analysis was done using IBM SPSS Statistics v27.

Results: Of the 117 patients in the current study, 71.8% were men and 28.2% were women. The mean age was 45.52±12.31 years, and the majority (45.3%) were between the ages of 36 and 50. The tumor's average size was 1.17±0.97 cm, and its average depth of invasion was 3.31±1.71 cm. 51 out of 117 patients (43.6%) in our study had nodal metastatic disease. There was significant association of nodal metastasis with tumor size (p=0.018), depth of invasion (p=0.002), and stage (p=0.000).

Conclusion: We discovered significant association between nodal metastasis with tumor size, depth of invasion, stage, peri-neural invasion, and extra-nodal extension. Nodal metastasis was more common in patients who were male, older than 35, had moderately differentiated tumors, and had peri-neural invasion.

Key Words: Oral Squamous Cell Carcinoma, Neck Node Metastasis, Prognostic Factors

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INTRODUCTION

Oral squamous cell carcinoma (OSCC) stands as one of the most prevalent forms of head and neck malignancies, accounting for significant morbidity and mortality worldwide. Among the myriad factors influencing the prognosis of OSCC, neck node metastasis emerges as a critical determinant, profoundly affecting survival rates and treatment outcomes[1]. According to the most recent data available, it is anticipated that there were around 177,757 deaths from lip and oral cavity cancer and 377,713 new instances of the disease worldwide in 2020. These tumours rank as the 18th most common type of cancer overall, out of all the neoplasm instances that have been reported. Squamous cell carcinomas make up more than 90% of these malignancies[2]. In addition to making clinical therapy more difficult, the existence of metastatic cervical lymph nodes calls for a thorough comprehension of the clinicopathological foundations of the condition. Oral squamous cell carcinoma, which arises from the oral epithelial lining, is the most prevalent type of cancer in the head and neck region[3]. Nearly 50% of newly diagnosed patients with OSCC have cervical node metastases, and it shows strong biological activity of growth and invasion together with regional lymph node metastases. One of the important predictors is the involvement of neck lymph nodes, and even if there is only one node, the overall survival rate decreases by 50% if the neck lymph node is positive. The methods of managing neck in oral SCC are contentious and whenever employed, they should be done effectively[4]. Nodal involvement, specifically cervical nodes in OSCC, is one of the critical predictors of prognosis and treatment plan in the clinical setting. The following processes are necessary for the development of this cancer: local progression and tumour cell invasion. The specialised epithelial cells of the oral cavity give birth to OSCC, which is mostly caused by genetic changes and secondarily by the

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effects of alcohol and tobacco use, which modify the levels of tumour suppressor genes and oncogenes[5].

Lymph Node Metastasis also known as the nodal involvement is the most unfavorable predictor of OSCC and has been estimated to affect forty percent of patients. Patients are diagnosed without lymph node metastases (LNM), according to the eighth American Joint Committee on Cancer (AJCC) staging criteria, they exhibit 5 year rates of survival overall above 80%; in contrast, patients who are comprising of stage N3 have a comparably low 5-year survival of about 20%. Surprisingly, the process of LNM in OSCC is still not well understood, although the management of cervical lymph nodes in OSCC remains a topic of debate even today[6]. The question of whether a contralateral lymph node dissection is required in intraoral SCCs has been the subject of a few investigations. Not all tumours crossing the midline have a high-risk, containing stage I and II tumours that do not involve the floor of the mouth, and not all tumours that do not affect the midline have a low-risk, containing stage III and IV tumours that involve the floor of the mouth, in relation to one study that explained a mathematical modelling approach to the evaluation of contralateral neck dissections in oral SCC[7]. Furthermore, there is a need to identify the clinical factors linked to nodal metastasis because radical neck dissection is associated with a high rate of morbidity. Our research may be useful in the patient stratification process for those who can benefit from selective neck dissection rather than radical neck dissection the prevalence of lymph node metastasis and its association with several clinicopathological variables.

METHODS

The department of oral and maxillofacial surgery at Liaquat University of Medical and Health Science in Jamshoro conducted this retrospective study in October 2024 and August 2025. The study included 117 cases of OSCC that were reported to our institute in total. All OSCC cases with biopsy evidence were included in the research. Institutional archives provided the clinicopathological information for the cases included in the study that were reported during the study period. Clinical referral forms provided the age, gender, and tumor site of the patient, among other clinical data.

RESULTS

This study included 117 patients with OSCC, of whom 71.8% were male and 28.2% were female. The mean age was 45.52 ± 12.31 years, with most patients (45.3%) between 36 and 50 years.

The average tumor size was 1.17 ± 0.97 cm, and the mean depth of invasion (DOI) was 3.31 ± 1.71 cm. Tumor staging showed that 7.7% were stage I, 19.7% stage II, 25.6% stage III, 35.9% stage IV-A, and 11.1% stage IV-B; T2 was the most frequent T-stage (33.3%).

Table No.I: Demographic and clinicopathological parameters

	n (%)
Gender: Male	84(71.8)
Female	33(28.2)
Age (years); Mean± Std. Dev	45.52±12.31
Age Group: ≤35 years	29(24.8)
36-50 years	53(45.3)
>50 years	35(29.9)
Tumor Size (cm); Mean± Std. Dev	3.31±1.71
Tumor Size Group : ≤2 cm	21(17.9)
2.1-4.0 cm	73(62.4)
>4 cm	23(19.7)
Depth of Invasion (cm); Mean± Std. Dev	1.17±0.97
Depth of Invasion Group	
<0.5 cm	16(13.7)
0.5-1.00 cm	49(41.9)
>1 cm	52(44.4)
Tumor Stage : Stage-I	9(7.7)
Stage-II	23(19.7)
Stage-III	30(25.6)
Stage IV-A	42(35.9)
Stage IV-B	13(11.1)
T Stage: T1	12(10.3)
T2	39(33.3)
T3	31(26.5)
T4	16(13.7)
T4a	19(16.2)
N Stage: N0	66(56.4)
N1	16(13.7)
N2a	2(1.7)
N2b	6(5.1)
N3b	5(4.3)
N2	1(0.9)
N2b	14(12)
N3b	7(6)
Tumor Site: Buccal mucosa	71(60.7)
Tongue	25(21.4)
Lower Lip	15(12.8)
Maxilla	3(2.6)
Lower alveolus	1(0.9)
Retromolar trigone	2(1.7)
Histological Type	
Moderately differentiated	114(97.4)
Well differentiated	3(2.6)
Lympho-vascular Invasion	3(2.6)
Peri-neural Invasion	13(11.1)
Extra nodal Extension	15(12.8)
Submandibular gland Invasion	2(1.7)
Nodal Metastasis	
Positive	51(43.6)
Negative	66(56.4)

The buccal mucosa was the predominant tumor site (60.7%), followed by the tongue (21.4%) and lower lip

(12.8%). Perineural invasion occurred in 11.1% of cases, extranodal extension in 12.8%, lymphovascular invasion in 2.6%, and submandibular gland invasion in 1.7%. Nodal metastasis was identified in 51 patients (43.6%), with Level-IB being the most common site of involvement (37.3%). Among node-positive patients, 62.7% had buccal mucosa tumors and 25.5% had tongue tumors. Nodal metastasis demonstrated significant associations with tumor size ($p = 0.018$), DOI ($p = 0.002$), and overall stage ($p < 0.001$). Smaller tumors (≤2 cm) and shallower DOI (<0.5 cm) had significantly lower odds of metastasis. N-stage was significantly associated with extranodal extension ($p < 0.001$) and submandibular gland invasion ($p = 0.032$).

Table No.2: Association and odds for nodal metastasis with demographic and clinicopathological parameters

	Nodal Metastasis		p-value	Odds Ratio (95% CI)	p-value
	Positive	**Negative**			
Gender					
Male	39(76.5)	45(68.2)	0.323	1.517(0.662-3.474)	0.325
Female	12(23.5)	21(31.8)		Ref	
Age Groups					
≤35 years	16(31.4)	13(19.7)	0.349	1.846(0.682-5.001)	0.228
36-50 years	21(41.2)	32(48.5)		0.984(0.412-2.354)	0.972
>50 years	14(27.5)	21(31.8)		Ref	
Tumor Size					
≤2 cm	4(7.8)	17(25.8)	0.018*	0.151(0.038-0.598)	0.007*
2.1-4.0 cm	33(64.7)	40(60.6)		0.530(0.204-1.379)	0.193
>4 cm	14(27.5)	9(13.6)		Ref	
Depth of Invasion					
<0.5 cm	2(3.9)	14(21.2)	0.002*	0.097(0.020-0.471)	0.004*
0.5-1.00 cm	18(35.3)	31(47)		0.393(0.176-0.878)	0.023*
>1 cm	31(60.8)	21(31.8)		Ref	
Tumor Stage					
Stage-I	0(0)	9(13.6)	0.000*	NA	0.999
Stage-II	0(0)	23(34.8)		NA	0.998
Stage-III	12(23.5)	18(27.3)		0.056(0.006-0.485)	0.009*
Stage IV-A	27(52.9)	15(22.7)		0.150(0.018-1.269)	0.082
Stage IV-B	12(23.5)	1(1.5)		Ref	
T Stage					
T1	3(5.9)	9(13.6)	0.282	0.300(0.061-1.467)	0.137
T2	16(31.4)	23(34.8)		0.626(0.208-1.888)	0.406
T3	12(23.5)	19(28.8)		0.568(0.179-1.804)	0.338
T4	10(19.6)	6(9.1)		1.500(0.387-5.814)	0.557
T4a	10(19.6)	9(13.6)		Ref	
Histological Type					
Moderately differentiated	50(98)	64(97)	1.000	1.562(0.138-17.727)	0.719
Well differentiated	1(2)	2(3)		Ref	

Chi-square/fisher exact test was applied.
Binary logistic regression was applied.
*Significant at 0.05 levels.

Table No.3: Association of N stage with demographic and clinicopathological parameters (n=51)

	N Stage							p-value
	N1	**N2a**	**N2b**	**N3b**	**N2**	**N2b**	**N3b**	
Gender								
Male	12(75)	2(100)	6(100)	3(60)	1(100)	10(71.4)	5(71.4)	0.773
Female	4(25)	0(0)	0(0)	2(40)	0(0)	4(28.6)	2(28.6)	
Age Groups								
≤35 years	4(25)	0(0)	1(16.7)	2(40)	0(0)	6(42.9)	3(42.9)	0.878
36-50 years	6(37.5)	2(100)	4(66.7)	2(40)	1(100)	4(28.6)	2(28.6)	
>50 years	6(37.5)	0(0)	1(16.7)	1(20)	0(0)	4(28.6)	2(28.6)	

Tumor Size								
≤2 cm	2(12.5)	0(0)	0(0)	0(0)	0(0)	1(7.1)	1(14.3)	0.206
2.1-4.0 cm	12(75)	2(100)	3(50)	2(40)	1(100)	11(78.6)	2(28.6)	
>4 cm	2(12.5)	0(0)	3(50)	3(60)	0(0)	2(14.3)	4(57.1)	
Depth of Invasion								
<0.5 cm	1(6.3)	0(0)	0(0)	0(0)	0(0)	0(0)	1(14.3)	0.113
0.5-1.00 cm	9(56.3)	0(0)	1(16.7)	0(0)	1(100)	6(42.9)	1(14.3)	
>1 cm	6(37.5)	2(100)	5(83.3)	5(100)	0(0)	8(57.1)	5(71.4)	
Tumor Stage								
Stage-III	12(75)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.000*
Stage IV-A	4(25)	2(100)	6(100)	0(0)	1(100)	14(100)	0(0)	
Stage IV-B	0(0)	0(0)	0(0)	5(100)	0(0)	0(0)	7(100)	
T Stage								
T1	1(6.3)	0(0)	0(0)	0(0)	0(0)	1(7.1)	1(14.3)	0.258
T2	9(56.3)	0(0)	0(0)	0(0)	1(100)	5(35.7)	1(14.3)	
T3	2(12.5)	1(50)	2(33.3)	2(40)	0(0)	4(28.6)	1(14.3)	
T4	1(6.3)	0(0)	2(33.3)	1(20)	0(0)	3(21.4)	3(42.9)	
T4a	3(18.8)	1(50)	2(33.3)	2(40)	0(0)	1(7.1)	1(14.3)	
Histological Type								
Moderately differentiated	15(93.8)	2(100)	6(100)	5(100)	1(100)	14(100)	7(100)	1.000
Well differentiated	1(6.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	
Lymph vascular Invasion								
Present	2(12.5)	0(0)	0(0)	0(0)	0(0)	1(7.1)	0(0)	1.000
Absent	14(87.5)	2(100)	6(100)	5(100)	1(100)	13(92.9)	7(100)	
Peri neural Invasion								
Present	4(25)	0(0)	2(33.3)	1(20)	0(0)	3(21.4)	19(14.3)	0.976
Absent	12(75)	2(100)	4(66.7)	4(80)	1(100)	11(78.6)	6(85.7)	
Extra nodal Extension								
Positive	0(0)	2(100)	1(16.7)	5(100)	0(0)	1(7.1)	6(85.7)	0.000*
Negative	16(100)	0(0)	5(83.3)	0(0)	1(100)	13(92.9)	1(14.3)	
Submandibular gland Invasion								
Positive	0(0)	0(0)	0(0)	2(40)	0(0)	0(0)	0(0)	0.032*
Negative	16(100)	2(100)	6(100)	3(60)	1(100)	14(100)	7(100)	

Chi-square/fisher exact test was applied.
*Significant at 0.05 levels.

DISCUSSION

This study provides a comprehensive evaluation of demographic, clinicopathological, and invasion characteristics among 117 patients with oral squamous cell carcinoma (OSCC), with a primary focus on nodal metastasis. Consistent with global trends, a greater proportion of OSCC cases occurred in men, reflecting established associations between male gender and lifestyle risk factors such as tobacco use, betel-quid chewing, and alcohol consumption[12]. Although the mean surface tumor diameter appeared small (1.17 cm), the average depth of invasion (DOI) was 3.31 cm, indicating biologically aggressive behavior despite modest surface dimensions. Most patients presented with advanced disease (stage IV-a and stage IV-b), underscoring persistent delays in diagnosis and the need to strengthen early detection pathways. The buccal mucosa was the most common tumor site, followed by the tongue and lower lip—anatomical regions frequently exposed to carcinogens in high-risk populations[13]. Invasion characteristics demonstrated notable incidences of perineural invasion (PNI) and extranodal extension (ENE), both regarded as adverse prognostic features in OSCC[14]. Submandibular gland invasion was relatively uncommon. Nodal metastasis remains one of the strongest predictors of survival in OSCC, and previous literature suggests that nodal

involvement can increase mortality risk by up to 50%[15]. In the present study, nodal metastasis was detected in 43.6% of patients. Level IB emerged as the most commonly involved nodal basin, reinforcing the need for meticulous clinical and radiologic assessment of this level. Buccal mucosa tumors exhibited the highest nodal involvement, consistent with earlier findings reporting their aggressive biological behavior and early lymphatic spread[13]. Our results corroborate evidence that DOI is a critical predictor of nodal metastasis. Tumors ≤2 cm with DOI <0.5 cm demonstrated markedly lower nodal involvement. Jangir et al. reported similar findings, identifying a DOI >5 mm as significantly associated with increased nodal metastasis[16]. Kane et al. similarly emphasized DOI >5 mm as a reliable predictor for cervical nodal spread[17]. Although gender did not show a statistically significant association with nodal metastasis in the present study, male patients exhibited higher odds of nodal positivity, aligning with the findings of Heft Neal et al[18]. The study also demonstrated that tumor size and PNI were significantly associated with nodal disease, consistent with prior reports linking PNI and larger tumor dimensions with more extensive lymphatic dissemination[14,19]. This study has several limitations. As a retrospective, single-center analysis, generalizability is limited. Follow-up data were not available to assess overall survival or disease-free survival. Treatment-related variables and biomarker correlations were not evaluated. Additionally, the absence of molecular markers limits insight into biological pathways underlying nodal spread. Future prospective, multicenter studies integrating clinicopathological and molecular parameters are warranted. Overall, these findings highlight the importance of early OSCC detection, careful assessment of DOI and PNI, and vigilant evaluation of Level IB lymph nodes. Strengthening early diagnostic strategies and risk-stratified management may improve outcomes in high-risk OSCC patients.

CONCLUSION

We discovered significant association between nodal metastasis with tumor size, depth of invasion, stage, peri-neural invasion, and extra-nodal extension. Nodal metastasis was more common in patients who were male, older than 35, had moderately differentiated tumors, and had peri-neural invasion. Furthermore, as the tumor's invasion depth and size increases, so does the risk of nodal metastasis. This study may aid in the patient stratification that would help prevent neck dissection by highlighting the major pathological predictors of nodal metastasis in OSCC.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Rubab Mannan Shaikh, Muhammad Rahil Khan
Drafting or Revising Critically:	Rubab Mannan Shaikh, Kashif Ali Channar,
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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