Original Article

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Diagnostic Accuracy of Computed Tomography in Diagnosing Mandibular Invasion in Patients with Already Known Oral Cancer

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Author`s Contribution

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ABSTRACT

Objective: To determine the diagnostic accuracy of computed tomography (CT) in diagnosing mandibular invasion in patients with already known oral cancer taking histopathology as gold standard.

Methodology: This cross-sectional study was conducted at department of Radiology, Liaquat University of Medical and Health Sciences, Jamshoro, from June 2022 till May 2023. Patients aged 25-80 years, both male and female patients, already diagnosed for oral cancer by biopsy and histopathology, presenting with swelling or pain in the lower jaw, scheduled for surgery and undergoing preoperative CT examination of the oral cavity and mandible were included. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of CT scan were calculated using 2 x 2 contingency tables using histopathological findings as gold standard.

Results: Mean age of the patients was 55.01 ± 12.71 years and mean duration of symptoms was 11.23±4.95 months. CT scan showed sensitivity, specificity, positive predicted value (PPV), negative predicted value (NPV) and overall diagnostic accuracy as 83.76%, 83.33%, 96.49%, 48.39% and 83.69% for detection of mandibular invasion taking histopathology as gold standard.

Conclusion: CT scan showed high sensitivity, specificity and diagnostic accuracy in diagnosis of mandibular invasion in cases of oral cancers.

Keywords: Oral cancer, Mandibular invasion, Diagnostic accuracy; Sensitivity, Specificity.

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Introduction

Oral cancer (OC) is a chronic and life-limiting condition that mainly involves the tongue, lips, buccal mucosa, floor of the mouth and oropharynx, and it remains a major public health-related issue throughout the world.[1] It not only affects the health but also creates a significant financial and social burden for patients, families, and the healthcare system.[1] In 2022, an approximated 389,846 new cases of lip and oral cavity carcinoma occurred globally,[2] and the tumors of oral cavity made up approximately 42% of the 758,000 lip, oral cavity and pharyngeal malignancies diagnosed that year.[3] Pakistan is among the most affected nations: oral carcinoma is its second most common malignancy overall and the most common among males, largely because of smokeless tobacco, areca nut and cigarette use.[4] Since most of oral cancer cases in this lower income nation occur among individuals of lower socioeconomic and education status, mandibular invasion is a fundamental factor of staging, planning of surgery and prognosis in the oral squamous cell carcinoma (OSCC). Involvement of bone occurs in around 12% to 56% of the patients, and because bone must be decalcified before histology, frozen-section

confirmation is not possible intraoperatively; resection extent therefore rests on preoperative evaluation.[5] Tumors that only erode the cortex can frequently be managed by marginal mandibulectomy, whereas cancellous invasion generally deserves segmental resection.[6] Under-staging risks inadequate margins and reoperation, whereas over-staging sacrifices mandibular continuity and needs complex reconstruction.[5]

Early diagnosis of this malignancy is essential to facilitate timely treatment and reduce morbidity and mortality. Accurate preoperative assessment is therefore crucial for appropriate oncological planning while avoiding unnecessary resection of uninvolved bone. As clinical examination alone may not reliably identify the presence or extent of mandibular invasion, cross-sectional imaging plays an important role in preoperative evaluation.[7,8]

CT, specifically contrast-enhanced CT with thin-section bone reconstruction, provides accurate visualization of cortical bone destruction and remains a very important imaging modality for the assessment of mandibular involvement in the oral cancer. It is widely available radiological modality that consumes less time and delivers promising findings. Despite earlier evidence of a higher specificity of CT for the detection of mandibular invasion, the sensitivity has varied considerably across the studies. According to a study, contrast-enhanced CT achieved 76.9% sensitivity, 82.2% specificity and 89.7% negative predictive value, with errors concentrated in T3 tumors and those with depth of invasion ≥10 mm,[4] and few other series reported sensitivity and specificity of 77.9% and 76.7%,[9] 100% and 46%,[10] and according to a national cohort, above 95% for both.[11] Moreover according to a large scale recent study involving 572 patients of CT-based evaluation demonstrated pooled sensitivity and specificity of around 63.4% and 90.8% respectively, with overall diagnostic accuracy of 84.3% for histologically confirmed bone invasion, with diagnostic performance varying according to anatomical subside. Based on the high regional burden of oral cancer, the central role of CT in the surgical planning, and the inconsistency of published estimates, the more recent local evidence is needed to reflect current clinical practice. Therefore, this study was aimed to evaluate the diagnostic accuracy of CT in detection of mandibular invasion among patients with oral cancer, taking histopathological results as the reference value. The assessment of overall diagnostic accuracy may help to determine the clinical usefulness of CT for preoperative surgical planning.

Methodology

This cross sectional study was conducted at the department of Radiology, Liaquat University of Medical and Health Sciences, Jamshoro. This study was conducted after obtaining approval of the synopsis from CPSP (Ref No: CPSP/REU/RAD-2019-164-2965), during the one year period from June 2022 till May 2023. Non-probability consecutive sampling technique was used. All the patients aged 25-80 years, both male and female patients, already diagnosed for oral cancer by biopsy and histopathology, presenting with swelling or pain in the lower jaw, scheduled for surgery and undergoing preoperative CT examination of the oral cavity and mandible were included. Patients who received radiotherapy, chemotherapy or surgery to the head and neck region before the CT scan, patients with recurrent oral carcinoma, patients with history of previous mandibular fracture, or mandibular surgery with other mandibular conditions like osteomyelitis, benign jaw tumors or cysts, or fibrous dysplasia, patients with dental implants or extensive metallic restorations that cause artefacts on CT, patients with raised serum creatinine or renal failure, or pregnancy and who refused to take part in this study were excluded. After taking informed consent, CT scan was performed in each case with intravenous contrast administration on a 16 slice CT scanner. Initially, a plain CT scan was acquired, followed by intravenous administration of contrast at a dose of 2 mL/kg body weight. A post-contrast CT scan was then acquired approximately 60–70 seconds after contrast injection. The CT scans were interpreted and reported by a consultant radiologist with five years of experience in CT reporting. The invasion of mandible was defined as area of erosion and destruction involving the body, ramus or condyle of the mandible by the oral cancer.

Subsequent to definitive surgical treatment, the resected mandibular specimen underwent routine histopathological examination. The specimens were appropriately oriented, sectioned, processed, and examined by the qualified histopathologist who assessed the association between the tumor and mandibular bone. The histopathological evidence of tumor infiltration into mandibular bone was considered positive as mandibular invasion. Data was analyzed by using SPSS version 26.0. Diagnostic accuracy of CT in diagnosing mandibular invasion, including sensitivity, specificity, PPV, and NPV were calculated using 2 x 2 contingency tables using histopathological findings as gold standard.

Results

The mean age of the patients was 55.01 ± 12.71 years, and the mean duration of symptoms was 11.23 ± 4.95 months. Males accounted for 73.39% of the study population. Most patients were married (63.09%). Smoking was the most commonly reported habit (66.95%), followed by a history of tobacco chewing in 41.2% of patients. CT findings were positive for mandibular invasion in 73.39% of cases, whereas histopathological examination confirmed mandibular invasion in 84.55% of cases. Table I

Using histopathology as the gold standard, CT correctly identified 165 of the 197 histopathologically positive cases, yielding a sensitivity of 83.76% and a specificity of 83.33%. The overall diagnostic accuracy was 83.69%.

Table I: Demographic and clinical characteristics of the patients. (n= 233)

Variable	Category	Percentage
Gender	Male	73.39%
	Female	26.61%
Marital Status	Married	63.09%
	Unmarried	36.91%
Tobacco Chewing	No	58.8%
	Yes	41.2%
Smoking	Yes	66.95%
	No	33.05%
CT Findings	Positive	73.39%
	Negative	26.61%
Histopathology Findings	Positive	84.55%
	Negative	15.45%

The positive predictive value (PPV) was 96.49%, indicating that most positive CT findings were confirmed by histopathology. Table II

Table II: Diagnostic accuracy of CT scan taking Histopathology as the gold standard. (n=233)

CT scan	Histopathology		
	Positive	**Negative**	**Total**
Positive	165	6	171
Negative	32	30	62
Total	197	36	233

Sensitivity = 83.76%, Specificity = 83.33%, PPV = 96.49% NPV = 48.39%, Diagnostic accuracy = 83.69%

Subgroup analysis showed that CT had a relatively high diagnostic accuracy across the evaluated groups. Accuracy was highest among patients with a symptom duration of more than 14 months (87.30%) and those older than 45 years (85.63%). It was comparatively lower among patients aged 45 years or younger (78.79%). The PPV remained high across subgroups, ranging from 92.31% to 98.32%, indicating that positive CT findings were generally confirmed by histopathology. In contrast, the negative predictive value (NPV) was relatively low in most subgroups, ranging from 33.33% to 63.64%. This suggests that a negative CT result may not reliably exclude mandibular invasion and should be interpreted alongside clinical findings and histopathological assessment. Table III

Discussion

Mandibular invasion is a significant indicator of

Table III: Diagnostic accuracy of CT scan taking Histopathology as the gold standard according to effect modifiers. (n=233)

Variables	Cross tabulation				Diagnostic accuracy
Age≤45	**CT scan**	**Histopathology**			
		Positive	**Negative**	**Total**	
	Positive	46	2	48	Sensitivity: 79.71%, Specificity: 75.00%
	Negative	12	6	18	PPV: 95.83%
	Total	58	8	66	NPV: 33.33%, DA: 78.79%
Age >45	Positive	119	4	123	Sensitivity: 85.61%, Specificity: 85.71%, PPV: 96.75%,
	Negative	20	24	44	NPV: 54.55%, Diagnostic accuracy: 85.63%
	Total	139	28	167	
Duration of symptoms ≤14 months	Positive	117	2	119	Sensitivity: 80.69%, Specificity: 92.00%
	Negative	28	23	51	PPV: 98.32%
	Total	145	25	170	NPV: 45.10%, DA: 82.35%
Duration of symptoms >14 months	Positive	48	4	52	Sensitivity: 92.31% Specificity: 63.64%, PPV: 92.31%,
	Negative	4	7	11	NPV: 63.64%
	Total	52	11	63	Diagnostic accuracy: 87.30%
Male gender	Positive	79	3	82	Sensitivity: 82.29% Specificity: 86.36%
	Negative	17	19	36	PPV: 96.34% NPV: 52.78%, Diagnostic accuracy: 83.05%
	Total	96	22	118	
Female gender	Positive	86	3	89	Sensitivity: 85.15%
	Negative	15	11	26	Specificity: 78.57%, PPV: 96.63%
	Total	101	14	115	NPV: 42.31%, DA: 84.35%
Smoking history	Positive	113	3	116	Sensitivity: 84.33%, Specificity: 86.36%
	Negative	21	19	40	PPV: 97.41%, NPV: 47.50%
	Total	134	22	156	Diagnostic accuracy: 84.62%

advanced oral carcinoma and directly influences staging of tumor, planning of surgery and the extent of mandibular resection. CT is widely used to evaluate the mandibular involvement, whereas its diagnostic accuracy requires validation against histopathological findings.

The present study evaluated the diagnostic accuracy of CT for detecting mandibular invasion in patients with oral cancer, using histopathology as the reference standard. The mean age of the patients was 55.01 ± 12.71 years, with males accounting for 73.39% of the study population and females for 26.61%. These findings are consistent with previous studies reporting a male predominance among patients with oral squamous cell carcinoma (OSCC). Younas et al.[13] reported that 75.58% of the 86 patients with OSCC treated at Mayo Hospital, Lahore, were male, with a male-to-female ratio of 3.6:1. However, their study population had a lower mean age of 47.02 years. Similarly, Naz et al.[14] reported that 83 (71%) patients were male and 33 (28%) were female, with a mean age of 46.66 ± 10.77 years. The consistent male predominance across these studies may be associated with differences in the prevalence of tobacco use and other risk-related habits between males and females.

According to currents study the CT findings were positive among 73.39% of patients, whereas histopathologically positive cases were 84.55%. CT therefore underestimated the number of positive cases, missing 32 of the 197 histopathologically confirmed cases. A similar pattern was observed by Naz N et al.,[14] who found positive CT findings for adjacent bone invasion among 56 patients and positive histopathological findings among 65 patients out of all 116 patients. Consistently, the study by Struckmeier AK et al[5] reported that the CT correctly detected mandibular invasion in 83 patients and correctly excluded it in 242 patients. Similar to our findings, Ketschau J et al.[12] reported positive CT findings (erosion or destruction) in 125 (21.9%) of the cases, while histologically confirmed bone invasion rate was 134 (23.6%). Underestimation of this kind is expected, because small or superficial lesions may not produce detectable changes on CT. The few cases of mandibular bone invasion may be missed on CT, because invasion is small, superficial, or the limited to early cortical involvement, as microscopic invasion may not produce obvious cortical or medullary bone destruction.

In this study overall sensitivity and specificity of CT were 83.76% and 83.33% respectively, for the diagnosis of mandibular invasion in oral cancer patients. Consistent findings have been reported by Struckmeier AK et al.,[5] who reported the sensitivity 76.85%, specificity 82.20%, PPV 47.14% and NPV 89.67% of CT in the detection of bone invasion among OSCC patients. The findings were also comparable to the study by Ketschau J et al.,[12] who reported that among 572 cases, 134 (23.6%) had bone invasion confirmed on histopathology and CT detected it with a sensitivity of 63.4%, a specificity of 90.8%, and an overall diagnostic accuracy of 84.3%. Our findings were consistent with those reported by Kumar et al.,[9] who found that CT had a sensitivity of 77.94%, specificity of 76.67%, positive predictive value (PPV) of 88.33%, negative predictive value (NPV) of 60.53%, and overall diagnostic accuracy of 77.55% for detecting mandibular involvement. Similarly, Singh et al.[15] evaluated the diagnostic role of CT in detecting mandibular invasion in patients with oral squamous cell carcinoma (OSCC). They reported that contrast-enhanced CT (CECT) demonstrated a sensitivity of nearly 100%, a specificity of 48.3%, and a PPV of 42.8%. Our findings were also comparable to those of Jawaid et al.,[16] who reported histopathological confirmation of mandibular invasion in 53.2% of cases. In their study, CECT achieved a sensitivity of 69.2%, specificity of 78.4%, PPV of 80.4%, NPV of 66.7%, and overall diagnostic accuracy of 73.3%.

Similar findings have been reported in other studies.[17–19] In contrast, Park et al.[20] reported a higher sensitivity of 83.5% but a lower specificity of 61.9%, with an overall diagnostic accuracy of 76.0%. These variations may reflect differences in tumour location, the extent and pattern of mandibular involvement, CT protocols, radiological criteria, and patient selection. Overall, the findings support the role of CT as a useful, non-invasive imaging modality for the preoperative assessment of mandibular invasion in patients with oral cancer. Its high PPV in the present study suggests that positive CT findings can provide valuable information for surgical planning. However, CT findings should be interpreted alongside clinical assessment and histopathological findings, where available.

Conclusion

The CT scan showed reliable diagnostic accuracy taking histopathological findings as reference standard, with 83.76% sensitivity, 83.33% specificity, and an overall accuracy of 83.69%, along with high PPV, indicating a positive CT finding as a reliable indicator of disease and can support initial clinical decision-making. Overall, CT scan is therefore a valuable, non-invasive first-line

diagnostic tool, but should complement histopathology rather than replacing it.

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