MEDICAL SCIENCE

Assessment of staging in gingival cancer: The value of computed tomography

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ABSTRACT

Purpose: To assess the values of computed tomography in T staging of gingival cancer. *Methods:* A retrospective cross-sectional study conducted with 102 patients who had CT-scans and pathology results of carcinoma of gingiva at Ho Chi Minh City Oncology Hospital. This study evaluated the diagnostic value of CT in assessing the stage and bone invasion of gingival cancer by comparing CT assessment and pathology assessment. *Results:* There were 102 cases of gingival cancer in the study sample, of which 46 cases had tumor surgically removed. CT measurements of tumor size showed a strong correlation with macroscopic measurements with a Spearman correlation coefficient of 0.77. CT showed high diagnostic value in assessing bone and retromolar trigone invasion with sensitivity of 97.6% and 88.8%, specificity of 71.4% and 91.7%, positive predictive value of 95.2% and 80.0%, negative predictive value of 83.3% and 95.7%, respectively. In comparison between CT-scans and histologic analysis in T staging, showed good agreement, with weighted kappa index of 0.6 (95% CI, 0.4–0.9). *Conclusion:* Computed tomography is a valuable method in T staging of gingival cancer. The CT assessment should evaluate factors according to 8th AJCC to accurately evaluate the disease stage.

Keywords: CT, cancer, gingiva, staging, invasion, metastasis.

1. INTRODUCTION

Oral cancer is the cause of death of 1100 cancer patient and continues to represent a major problem worldwide (Sung et al., 2021). Gingival cancer is a relatively uncommon subgroup of oral cancer but unique among other oral primary sites (Barasch et al., 1995; Dijk et al., 2016). The major preventable risk factors are well established and the ability to detect abnormal lesions during physical examination should result in early diagnosis. However, advanced-stage gingival cancer is diagnosed often and carries with it the likelihood of a significant impact on a patient's functional capacity for speech and swallowing before and after treatment (Kariya et al., 2022).

Therefore, staging in gingival cancer plays an important role in treatment

consideration and prognosis. Depth of invasion and extra nodal extension are independent risk factors for local recurrence and five-year survival rate (Wreesmann et al., 2016; Prabhu et al., 2014). Computed tomography (CT) is one of the methods of choice in evaluating the extent of primary tumor and cervical lymph nodes because of its wide field of view, rapidly acquire and high-resolution images, affordable cost and wide availability throughout clinics and hospitals. However, research on characteristic CT imaging of gingival cancer is limited and sub site cancers are often grouped together as oral cancer, which leads to difficulty in data interpretation often. Therefore, we conducted this study to assess the value of CT in staging gingival cancer.

2. MATERIALS AND METHOD

Patient selection

All patients who were diagnosed with gingival cancer at Ho Chi Minh city Oncology Hospital between September 2022 and April 2023. They patients had contrast-enhanced CT scan of the head and neck region performed at our hospital and had biopsy specimen at our Pathology Department were involved in the study. We decided to exclude all the patients who had recurrent gingival cancer, CT scan performed elsewhere, diffuse imaging artifacts that hampered radiological assessment.

Method

To address the research purpose, we designed and implemented a retrospective cross-sectional study. The sample size was calculated based on kappa from prior research. We chose a desired kappa of 0.63 (Tâm, 2020), with the lowest kappa of 0.41 (moderate agreement). The proportion of anticipated pathological T stage from T1 to T4 was 28.2%; 13.7%; 1.7%; 56.4%, respectively (Lin et al., 2021). We used "kappaSize" from R application to calculate the sample size (Rotondi, 2018). The study population needed at least 42 patients. Convenience sampling method was applied. We reviewed our hospital database for all patients who had all inclusion criteria from August 1st 2019 to July 30th 2022.

All CT examinations were performed with a 64-detector row (Optima 660, GE, America) and a 16-detector row (Bright Speed Elite, GE, America) with 120 KVp, modulated tube current and section thickness and reconstruction interval of 0.625mm. Patients underwent unenhanced scanning from skull base to thoracic inlet, followed by 45-s delay acquisition. A 1.5 mL/kg dose of iopromide (Ultravist 300, Bayer Pharma, Berlin, Germany) was administered with a power injector at a flow rate of 2 mL/s. All images were sent to our picture archiving and communications system (PACS). The weighted kappa was used to assess the agreement between CT scan evaluation and histological evaluation regarding T stage. All statistical analyses were performed using SPSS (version 25, SPSS Inc., NY).

3. RESULTS

A cross-sectional study of 102 patients was extracted after application of the inclusion and exclusion criteria. Three patients were discarded due to imaging artifacts, 30 because they had CT scan performed elsewhere. 21 patients were excluded because of the unavailability of biopsy samples at our hospital. 46 (45.1%) patients had the tumor surgically removed. There is a strong correlation between tumor dimension in maximum diameter when evaluated with CT and that when evaluated during operating with Spearman's correlation of 0.77 (Chart 1).

The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) in identifying retromolar trigone invasion were 88.8%, 91.7%, 80.0%, 96.7% respectively (Table 1). The sensitivity, specificity, PPV and NPV in detecting bone invasion in gingival cancer were 97.6%, 71.4%, 95.2%, 83.3% respectively (Table 2).

There was a good agreement between CT and pathology in diagnosing T stage with weighted kappa value of 0.6 (Table 3). CT and pathology had a good agreement on evaluating N stage of gingival carcinoma with weighted kappa value of 0.6 (Table 4).

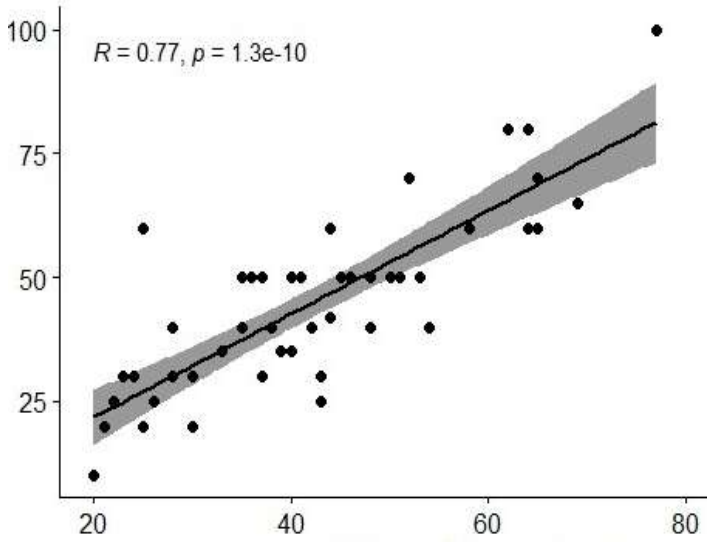

Chart 1 Correlation between tumor CT maximum diameter and tumor surgical maximum diameter

Table 1 The value of CT in assessment of retromolar trigone invasion

Retromolar trigone invasion		Surgery		
		Yes	No	Total
CT	Yes	8	2	10
	No	1	22	23
	Total	9	24	33

Table 2 Results of CT in the assessment of mandibular invasion

Bone invasion		Surgery		
		Yes	No	Total
CT	Yes	40	2	42
	No	1	5	6
	Total	41	7	48

Table 3 The comparison of pathology assessment and CT assessment for the evaluation of T stage of gingival carcinoma

T stage		Pathology			
		T1	T2	T3	T4
CT	T1	0	0	0	0
	T2	0	1	0	0
	T3	0	3	1	1
	T4	0	1	0	41
Kappa		0.6 (95% CI 0.2-0.8)			
Weighted Kappa		0.6 (95% CI 0.4-0.9)			

Table 4 The comparison of pathology assessment and CT assessment for the evaluation of N stage of gingival carcinoma

N stage		Pathology			
		N0	N1	N2	N3
CT	N0	27	2	1	0
	N1	1	3	3	1
	N2	1	3	4	2
	N3	0	0	0	0
Kappa		0.5 (CI 95% 0.3-0.7)			

Weighted Kappa	0.6 (CI 95% 0.4-0.8)

4. DISCUSSION

Evaluation of tumor size

Although tumor size can be assessed through clinical examination, imaging plays a crucial role in evaluating tumor with great size and extension. Our study shows a good correlation between tumor greatest dimension measured in CT and that measured when operating with Spearman's coefficient of 0.77.

Local extension assessment

Tumor extension into the retromolar trigone is of particular concern because this structure provides numerous routes of spread, making surgical treatment more difficult. Once reached the retromolar trigone, tumor might extend into masticator space, pterygoid plates and skull base. A tumor might directly invade mandibular nerve, which lies near the retromolar trigone and spread around the nerve to get into intracranial space. In our study, the sensitivity, specificity, positive predictive value and negative predictive value for CT evaluation of retromolar trigone was high (88.8%, 91.7%, 80.0% and 95.7%). According to prior studies, CT has high specificity and positive predictive value in detecting mandibular bone invasion.

However, there were few authors who reported the diagnostic values of CT in maxillary bone invasion in gingival cancer. Our study showed high diagnostic values of CT with sensitivity of 97.6%, specificity of 71.4%, positive predictive value of 95.2% and negative predictive value of 83.3%. Uribe et al., (2013), Li et al., (2014), Nae et al., (2019) and Lee et al., (2019) reported that CT had a sensitivity varying from 72 – 86% for detecting bone invasion. The above-mentioned studies acquired their images using sections from 1.5 to 3 mm. In contrast to these studies, our CT scans were performed with 0.625 mm sections meaning a higher resolution and more defined images which could lead to a higher sensitivity (Table 5).

Table 5 Review of studies examining the accuracy of CT in the assessment of bone invasion in patients with oral cancer

Study	Handschel et al., (2012)	Handschel et al., (2012)	Handschel et al., (2012)	Handschel et al., (2012)	Handschel et al., (2012)
Year of publication	2011	2018	2019	2014	2013
Site of tumors	Oral cavity	Gingiva	Floor of mouth, lower alveolus, retromolar trigone	Head and neck	Oral cavity
Imaging modalities	CT	CT, MRI, PET-CT	CT, MRI	CT	CT
Sample size	107	40	45	1459	243
Sensitivity	82.6%	88%	86%	72%	83%
Specificity	86.9%	80%	80%	90%	100%
Positive predictive value	82.6%	88%	73%	-	-
Negative predictive value	86.9%	80%	84.2%	-	-
Positive likelihood ratio	-	-	-	5.33	-
Negative likelihood ratio	-	-	-	0.36	-

The diagnostic value of CT in T stage assessment of gingival cancer

In our study, when comparing T stage on CT and pathology, we calculated a weighted Kappa value of 0.6, which means that the results of T stage assessment on CT and pathology have good agreement. According to our understanding, in the current literature, there is no research to evaluate the consensus between CT and pathology in evaluate T stage of gingival cancer. However, when compared with studies of in other sites of oral cancer such as the tongue, Tâm, (2020) study reported a similar Kappa coefficient of 0.63. Our study showed that CT is an appropriate means of assessing T stage in gingival cancer patients with high consensus with pathology results.

Further analysis, our study showed that CT is more suitable in evaluating T3 and T4 than T2. In 4 cases of pT2 that we assessed the T stage incorrectly on CT, 3 cases of pT2 were overestimated as T3 on CT due to tumor size > 2 cm and ≤ 4 cm and DOI > 10 mm. However, these 3 cases were not evaluated for DOI on pathology, so the pT2 stage was the result evaluated based on the tumor size alone according to AJCC version 7. The remaining case was evaluated as T4 on CT scan due to a cortical bone defect adjacent to the tumor; however, the result of intraoperative bone invasion examination was negative.

Moreover, there was information about microscopic bone invasion. This is a limitation of our retrospective study design. We therefore recommend that in the future there should be a confirmation of bone invasion on pathology when there is a discrepancy in the result of imaging modalities and intraoperative evaluation of bone invasion. In addition, this case was one of a few cases that have DOI evaluated on pathology in our study. The pathological DOI was 6mm, lower than the CT-based DOI (10mm). One of the reasons for this situation is that most of the cases of gingival cancer in the study were biopsied before the CT scan, which could lead to edema, hemorrhage, infiltration around the tumor. So DOI measured in CT could be inaccurate.

For large tumors, this problem might be insignificant because of the high likelihood of tumor extension into surrounding structures (T4), especially into bone; therefore, it would have little effect on the stage assessment by imaging studies. Besides, the specimen can shrink up to 30% after formalin fixation, depending on the specific anatomical position in the oral cavity. This rate for gingival cancer is 9.5% (Amin et al., 2018; El-Fol et al., 2015). To overcome this limitation, some authors introduce shrinkage factor for each CT plane to increase the accuracy of DOI on imaging. The shrinkage factor of oral cancers is generally 0.82–0.87 (Locatello et al., 2020).

5. CONCLUSION

Measuring tumor size on CT showed strong correlation with macroscopic measurement with Spearman correlation coefficient of 0.77. For the evaluation of the two most common invasive sites, bone invasion and retromolar trigone invasion, CT showed high diagnostic values with sensitivity of 97.6% and 88.8%, specificity of 71.4% and 91.7%, positive predictive value 95.2% and 80.0%, negative predictive value 83.3% and 95.7%, respectively. CT showed a high agreement with the pathological results in staging T with the weighted Kappa coefficient of 0.6 (0.4 – 0.9).

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Ethical approval

The study was approved by the Medical Ethics Committee of Ho Chi Minh city Oncology Hospital (IRB number: 29.2022-OH).

Author contributions

DKP and DVHcontributed equally to this work.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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