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Preoperative Detection of Mandibular Invasion in Oral Squamous Cell Carcinoma Using Cone-Beam Computed Tomography: Validation Against Surgical and Histopathological Findings

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ABSTRACT:

Background:

Mandibular invasion by OSCC is an important determinant of treatment planning and surgical extent. Accurate preoperative identification of bone involvement is therefore essential for achieving adequate oncological clearance while avoiding unnecessarily extensive mandibular resection. Cone-beam computed tomography (CBCT) provides detailed visualization of osseous structures and may assist in the assessment of mandibular involvement.

Aim:

To evaluate the diagnostic performance of CBCT in the preoperative detection of mandibular invasion in patients with OSCC and to compare CBCT findings with intraoperative surgical assessment and histopathological examination

Materials and Methods:

A total of 60 patients with OSCC who underwent preoperative CBCT evaluation followed by surgical management were included. CBCT images were assessed for radiographic features of mandibular involvement, including cortical erosion or destruction, medullary bone involvement, inferior alveolar canal involvement, and pathological mandibular fracture. The overall CBCT interpretation was categorized as positive or negative for mandibular invasion. Intraoperative findings and

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histopathological examination of the resected specimens were subsequently documented. Histopathology was considered the definitive reference standard, while intraoperative assessment was evaluated separately as a surgical reference standard. Diagnostic indices, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, and likelihood ratios, were calculated.

Results:

CBCT identified mandibular invasion in 34 of 60 cases (56.7%). Histopathological examination confirmed mandibular invasion in 32 cases (53.3%), while intraoperative assessment demonstrated gross mandibular involvement in 31 cases (51.7%). When compared with histopathology, CBCT demonstrated a sensitivity of 93.8%, specificity of 85.7%, PPV of 88.2%, NPV of 92.3%, and overall diagnostic accuracy of 90.0%. The positive and negative likelihood ratios were 6.56 and 0.07, respectively. Using intraoperative findings as the reference standard, CBCT demonstrated a sensitivity of 93.5%, specificity of 82.8%, PPV of 85.3%, NPV of 92.3%, and diagnostic accuracy of 88.3%.

Conclusion:

CBCT demonstrated high sensitivity and good overall diagnostic accuracy for the preoperative detection of mandibular invasion in OSCC. Its strong negative predictive value and low negative likelihood ratio suggest particular usefulness in excluding clinically significant mandibular involvement. CBCT may therefore serve as a valuable component of preoperative imaging assessment and surgical planning in patients with OSCC.

INTRODUCTION

Oral squamous cell carcinoma (OSCC) is the most common malignant neoplasm affecting the oral cavity and remains a major global health concern because of its considerable morbidity and mortality. The clinical outcome of OSCC is influenced by several factors, including primary tumor size, regional lymph-node involvement, distant metastasis, and the extent of local tissue invasion. Among the features that significantly influence treatment planning and prognosis, involvement of the mandible is particularly important because it may require extensive surgical resection and can substantially affect mastication, speech, facial appearance, and overall quality of life [1].

Mandibular invasion in OSCC may occur through direct extension from the adjacent mucosa into the underlying periosteum and cortical bone, followed by progression into the medullary compartment. The pattern and extent of osseous involvement can vary considerably among patients and may not always be accurately determined by clinical examination alone. Recognition of mandibular involvement before surgery is therefore essential for establishing the appropriate surgical margins, selecting the type of mandibular resection, and achieving adequate oncological clearance [2].

Conventional radiographic examinations, including panoramic and intraoral radiography, can demonstrate advanced bone destruction but may have limited sensitivity for detecting early or subtle mandibular involvement. Superimposition of anatomical structures and the inability to provide comprehensive three-dimensional (3D) information can further restrict their usefulness in detailed preoperative assessment. Cross-sectional imaging techniques have consequently become increasingly important in evaluating the relationship between oral tumors and adjacent osseous structures [3].

Cone-beam computed tomography (CBCT) provides high-resolution 3D visualization of the maxillofacial skeleton and permits multiplanar assessment of mandibular cortical and trabecular structures. The ability to examine axial, sagittal, and coronal reconstructions allows clinicians to identify cortical interruption, medullary bone destruction, and the approximate anatomical extent of osseous involvement. These characteristics make CBCT a potentially valuable modality for preoperative evaluation of mandibular invasion in patients with OSCC [4].

An additional advantage of CBCT is its capacity to provide detailed information regarding the spatial relationship between the tumor region and important mandibular anatomical structures. Such information may assist the surgical team in anticipating the extent of bone involvement and planning an appropriate resection. Accurate preoperative imaging may also help distinguish patients who require segmental or marginal mandibular resection from those in whom preservation of the mandibular continuity may be feasible [5].

Despite these advantages, radiological evidence of mandibular involvement does not invariably correspond to actual microscopic tumor infiltration. Inflammatory changes, cortical remodeling, pressure-induced bone resorption, and other reactive alterations may mimic malignant invasion on imaging. Conversely, microscopic extension of tumor cells beyond radiographically apparent abnormalities may remain undetected. Therefore, imaging findings should be interpreted carefully and preferably evaluated against definitive surgical and histopathological evidence [6].

Histopathological examination of the resected mandibular specimen provides direct evidence of tumor infiltration and is widely regarded as an important reference standard for determining the true status of bone invasion. Intraoperative assessment also provides valuable information regarding the macroscopic appearance and extent of osseous involvement. Correlation of preoperative CBCT findings with surgical observations and histopathological results can consequently provide a more meaningful assessment of the diagnostic performance of CBCT [7].

Evaluation of diagnostic accuracy requires consideration of parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall agreement with the reference standard. Determining these measures can establish the clinical reliability of CBCT and help identify whether the modality is more likely to overestimate or underestimate mandibular involvement. Such information is particularly relevant because both inadequate resection and unnecessarily extensive surgery may have significant consequences for patients with OSCC [8] [9].

Therefore, systematic assessment of CBCT findings against surgical and histopathological observations is important for determining its role in the preoperative evaluation of mandibular invasion. The present study was designed to evaluate the diagnostic accuracy of CBCT for detecting mandibular involvement in patients with OSCC to correlate the radiological findings with intraoperative surgical findings and histopathological results. The study aims to determine the reliability of CBCT as a preoperative imaging tool and to assess its potential contribution to individualized surgical planning and optimal oncological management.

MATERIALS & METHODS

This observational diagnostic accuracy study was conducted at a single tertiary care center from January to December 2025 and included 60 patients diagnosed with OSCC who underwent preoperative CBCT evaluation for suspected or possible mandibular involvement and subsequently received surgical treatment. The study was designed to determine the ability of CBCT to identify mandibular invasion before surgery and to assess its agreement with intraoperative findings and postoperative histopathological examination.

Inclusion Criteria

- Patients aged 18 years or older with a histopathologically confirmed diagnosis of OSCC
- Patients who underwent preoperative CBCT for evaluation of suspected or potential mandibular involvement
- Patients who subsequently underwent definitive surgical treatment for OSCC.
- Patients with adequate CBCT images and complete surgical and histopathological records sufficient for assessment of mandibular invasion

Exclusion Criteria

- Patients with poor-quality or inadequate CBCT images that precluded reliable assessment of mandibular involvement
- Patients with incomplete surgical or histopathological records required to determine mandibular invasion

- Patients who did not undergo definitive surgical treatment following CBCT evaluation
- Cases with insufficient clinical, radiological, surgical, or histopathological information for diagnostic accuracy analysis.

CBCT Examination

Preoperative CBCT examinations were evaluated for evidence of mandibular involvement by oral and maxillofacial imaging assessment. The radiographic evaluation focused on the presence or absence of specific osseous changes associated with tumor invasion. The recorded CBCT features included:

- Cortical erosion or destruction
- Medullary bone involvement
- Involvement of the inferior alveolar canal and
- Pathological mandibular fracture

Following evaluation of the individual radiographic features, each case was assigned an overall CBCT interpretation of positive or negative for mandibular invasion. When more than one radiographic feature was present in the same patient, each finding was recorded separately.

Intraoperative Assessment

The operative findings were reviewed to determine the presence or absence of gross mandibular involvement at the time of surgery. Cases were categorized as demonstrating gross mandibular involvement when direct intraoperative assessment identified apparent tumor-related involvement of the mandible. The surgical procedure performed was also documented and classified as segmental mandibulectomy, marginal mandibulectomy, or no mandibular resection. Intraoperative assessment was subsequently used as an independent reference standard to evaluate the diagnostic performance of preoperative CBCT.

Histopathological Assessment

Histopathological examination of the surgical specimens was performed following resection. The presence or absence of mandibular invasion was determined by microscopic examination of the submitted mandibular tissue and tumor-bearing specimens. Histopathological assessment was considered the definitive reference standard for determining whether mandibular invasion was present. Cases were categorized as either histopathologically confirmed mandibular invasion or no histopathological evidence of mandibular invasion. The histopathological findings were then compared with the corresponding preoperative CBCT interpretation.

Diagnostic Classification

For comparison with the reference standards, CBCT findings were categorized into four diagnostic outcomes:

- **True positive (TP):** CBCT indicated mandibular invasion and the reference assessment confirmed invasion
- **True negative (TN):** CBCT showed no mandibular invasion and the reference assessment confirmed its absence
- **False positive (FP):** CBCT indicated mandibular invasion, but the reference assessment showed no invasion
- **False negative (FN):** CBCT showed no mandibular invasion despite confirmation of invasion by the reference assessment

These classifications were established separately for histopathological and intraoperative comparisons.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Appropriate descriptive and inferential statistical methods were applied according to the type and distribution of the data. Continuous variables, including age, were expressed as mean ±

standard deviation (SD) and categorical variables were summarized as frequencies and percentages. The diagnostic performance of CBCT for detection of mandibular invasion was assessed separately using intraoperative surgical findings and histopathological findings as reference standards. For each comparison, TP, TN, FP, and FN values were determined. Diagnostic accuracy was evaluated by calculating sensitivity, specificity, PPV, NPV, positive likelihood ratio (LR+) and negative likelihood ratio (LR−). Agreement between CBCT and the reference findings was assessed using an appropriate measure of concordance, such as Cohen's kappa coefficient. Associations between categorical variables, where applicable, were evaluated using the Chi-square test or Fisher's exact test depending on expected cell frequencies. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1 & Figure 1 summarize the demographic characteristics of the 60 patients with OSCC who underwent CBCT evaluation for mandibular invasion. The mean age was 57.4 ± 10.8 years, with participants ranging from 32 to 78 years. A marked male predominance was observed, comprising 42 males (70.0%), compared with 18 females (30.0%). Overall, the study population primarily consisted of middle-aged and older adults, with men representing approximately two-thirds of the included cases.

Table 1: Study population and demographic characteristics

Parameter	n (%) / Mean ± SD
Total number of cases	60 (100.0%)
Age (years)	57.4 ± 10.8
Age range (years)	32–78
Male	42 (70.0%)
Female	18 (30.0%)

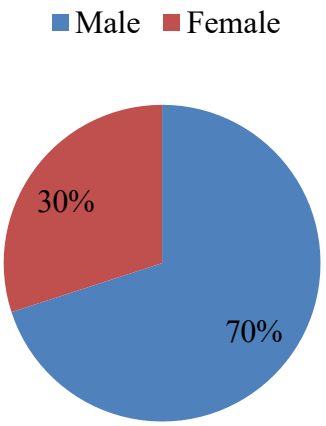

Figure 1: Age and gender distribution of patients with OSCC included in the study

Table 2 & Figure 2 present the distribution of OSCC according to the primary tumor site and the clinical assessment of mandibular involvement. Among the 60 cases, the buccal mucosa/alveolar region was the most frequently affected site, comprising 22 cases (36.7%). This was followed by the mandibular gingiva/ retromolar region, which accounted for 16 cases (26.7%). Tumors involving the tongue/floor of the mouth were identified in 12 cases (20.0%), while 10 cases (16.6%) involved other oral sites. On clinical examination, 36 patients (60.0%) were suspected to have mandibular invasion, whereas 24 patients (40.0%) showed no definite clinical evidence of mandibular involvement. Overall, tumors arising from the buccal

mucosa/alveolar and mandibular gingiva/ retromolar regions represented the predominant sites, and clinical suspicion of mandibular invasion was noted in more than half of the study population.

Table 2: Clinical and tumor characteristics

Clinical parameter	n (%)
Buccal mucosa/alveolar region	22 (36.7%)
Mandibular gingiva/ retromolar region	16 (26.7%)
Tongue/floor of mouth	12 (20.0%)
Other oral sites	10 (16.6%)
Clinically suspected mandibular invasion	36 (60.0%)
No definite clinical mandibular invasion	24 (40.0%)

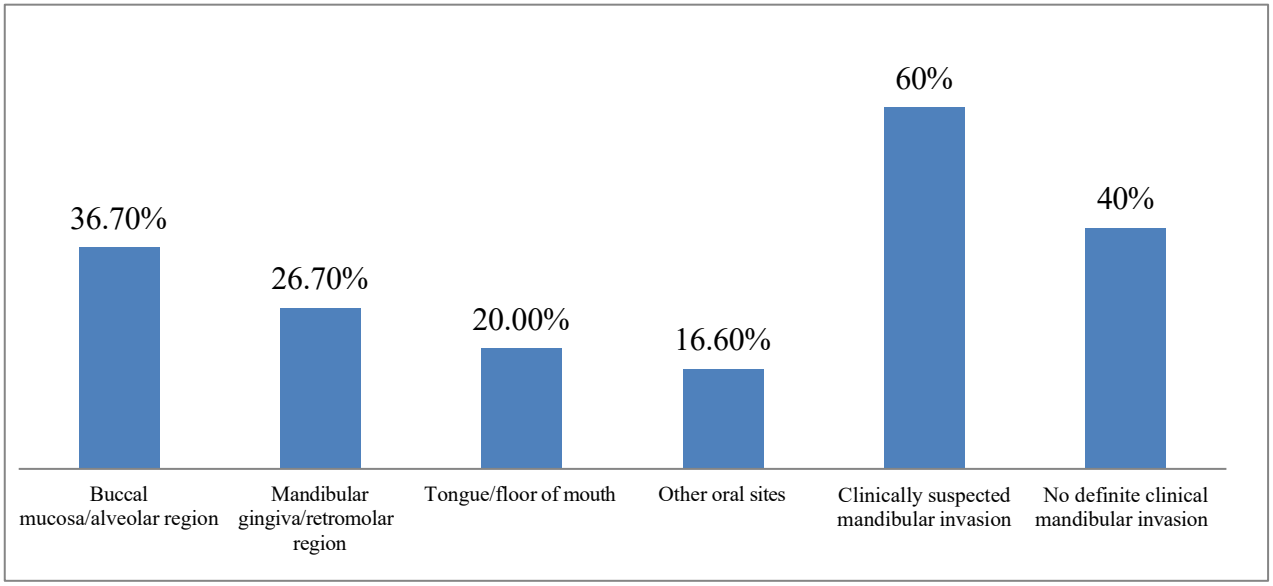

Figure 2: Distribution of OSCC cases according to primary tumor site and clinical suspicion of mandibular invasion

Table 3 & Figure 3 summarize the CBCT findings related to mandibular involvement. Cortical erosion or destruction was the most frequently detected feature, occurring in 34 cases (56.7%). Medullary bone involvement was identified in 29 cases (48.3%), whereas inferior alveolar canal involvement was observed in 15 cases (25.0%). Pathological mandibular fracture was comparatively rare and was detected in 5 cases (8.3%).

Based on the overall CBCT interpretation, 34 cases (56.7%) were considered positive for mandibular invasion, while 26 cases (43.3%) showed no evidence of mandibular invasion. As multiple radiographic features could be present simultaneously in the same patient, the individual feature percentages were not expected to add up to 100%.

Table 3: CBCT assessment of mandibular invasion

CBCT finding	n (%)
Cortical erosion/destruction	34 (56.7%)
Medullary bone involvement	29 (48.3%)

Inferior alveolar canal involvement	15 (25.0%)
Pathological mandibular fracture	5 (8.3%)
CBCT positive for mandibular invasion	34 (56.7%)
CBCT negative for mandibular invasion	26 (43.3%)

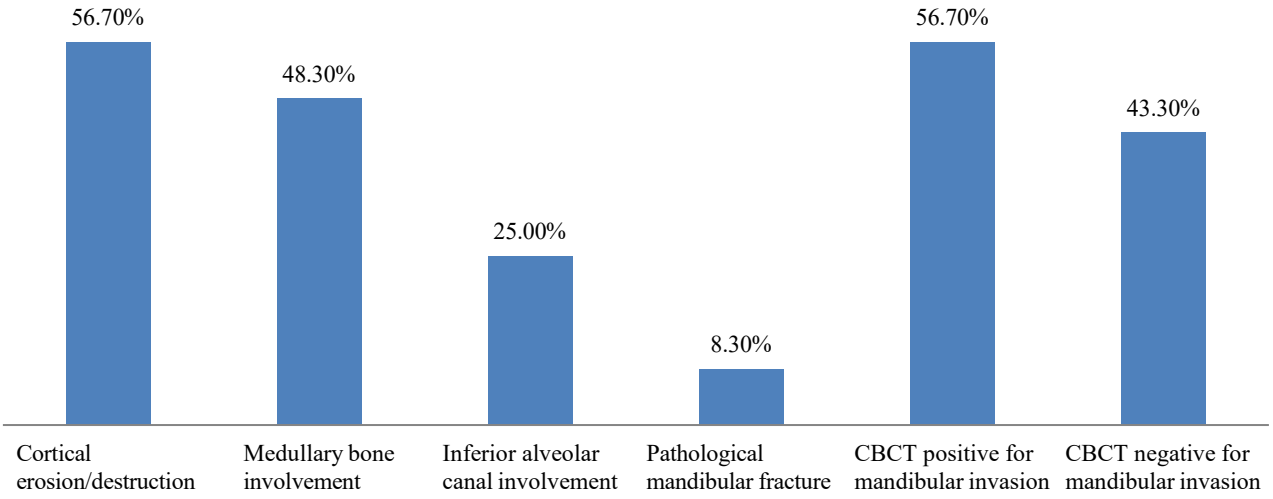

Figure 3: Distribution of CBCT findings indicative of mandibular invasion in OSCC

Table 4 & Figure 4 present the intraoperative findings and the surgical management of mandibular involvement. Gross evidence of mandibular involvement was identified intraoperatively in 31 cases (51.7%), whereas 29 cases (48.3%) showed no apparent mandibular involvement. Among the surgical procedures performed, segmental mandibulectomy was the most frequently undertaken procedure, accounting for 28 cases (46.7%), followed by marginal mandibulectomy in 22 cases (36.7%). Mandibular resection was not required in 10 cases (16.6%). These findings indicate that gross mandibular involvement was present in slightly more than half of the cases, with segmental mandibulectomy representing the predominant form of mandibular resection.

Table 4: Intraoperative/surgical findings of mandibular invasion

Surgical parameter	**n (%)**
Gross mandibular involvement present	31 (51.7%)
No gross mandibular involvement	29 (48.3%)
Segmental mandibulectomy	28 (46.7%)
Marginal mandibulectomy	22 (36.7%)
No mandibular resection	10 (16.6%)

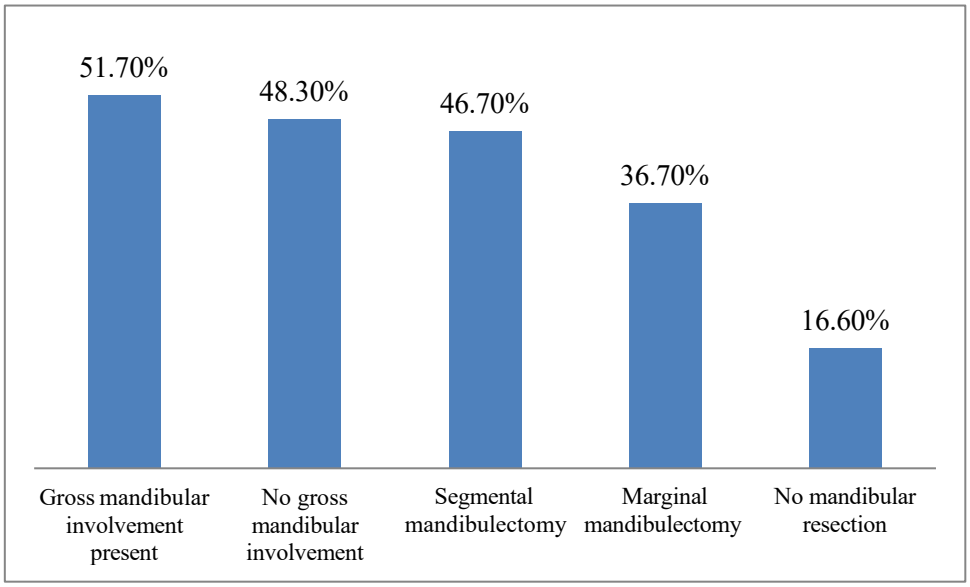

Figure 4: Intraoperative assessment of mandibular involvement and distribution of surgical procedures

Table 5 & Figure 5 summarize the histopathological findings regarding mandibular involvement. Histopathological examination, used as the reference standard for determining mandibular invasion, confirmed bone invasion in 32 cases (53.3%), while 28 cases (46.7%) showed no histological evidence of mandibular involvement. Overall, histopathology demonstrated mandibular invasion in slightly more than half of the study cases, indicating a considerable prevalence of underlying bony involvement among patients with OSCC.

Table 5: Histopathological assessment of mandibular invasion

Histopathological finding	**n (%)**
Mandibular invasion present	32 (53.3%)
Mandibular invasion absent	28 (46.7%)

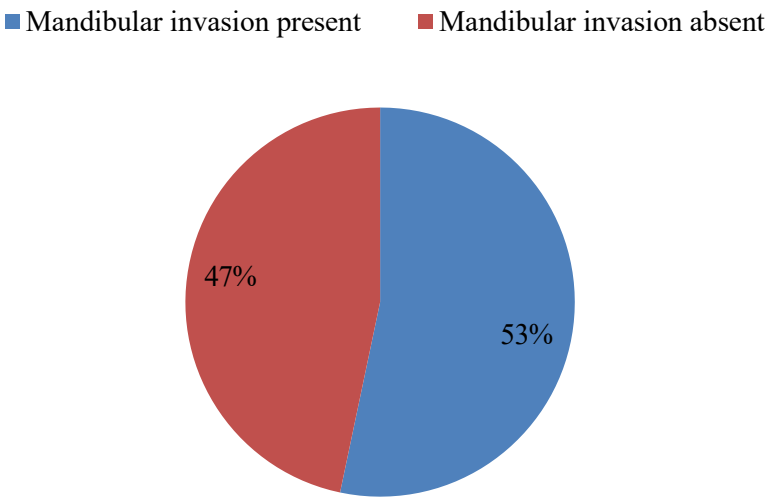

Figure 5: Histopathological assessment of mandibular invasion in OSCC

Table 6 & Figure 6 illustrate the diagnostic agreement between CBCT assessment and histopathological findings. Of the 32 cases in which mandibular invasion were confirmed histopathologically, CBCT correctly detected 30 cases as TP, while 2 cases were interpreted as negative, representing FN results. Among the 28 cases without histopathologically confirmed mandibular invasion, CBCT correctly classified 24 cases as TN, whereas 4 cases were incorrectly identified as positive, constituting FP results. Overall, CBCT findings agreed with the histopathological reference standard in 54 of 60 cases (90.0%), indicating a high level of diagnostic concordance for the preoperative assessment of mandibular invasion.

Table 6: Correlation of CBCT findings with histopathology

CBCT result	Histopathology: Invasion +	Histopathology: Invasion −	Total
Invasion positive	30 (TP)	4 (FP)	34
Invasion negative	2 (FN)	24 (TN)	26
Total	32	28	60

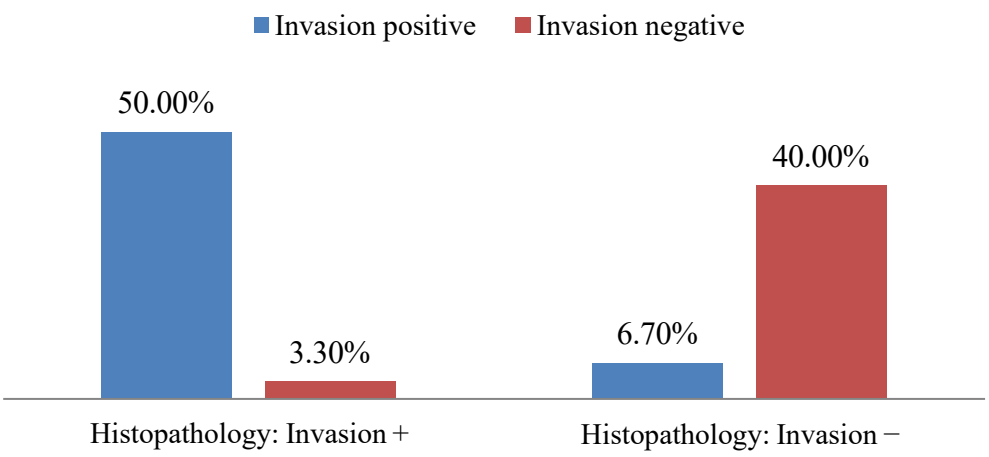

Figure 6: Comparison of CBCT findings with histopathological assessment of mandibular invasion

Table 7 & Figure 7 present the diagnostic performance of CBCT for identifying mandibular invasion, with histopathological examination serving as the reference standard. Among the 32 cases with histologically confirmed mandibular invasion, CBCT correctly detected 30 cases (TP) and failed to identify 2 cases (FN). Of the 28 cases without histopathological evidence of mandibular invasion, 24 were correctly classified as negative (TN), whereas 4 were incorrectly categorized as positive (FP).

The diagnostic evaluation showed a sensitivity of 93.8% and a specificity of 85.7%. The PPV was 88.2%, while the NPV was 92.3%. The overall diagnostic accuracy was 90.0%. The LR+ was 6.56, indicating a substantial increase in the probability of mandibular invasion following a positive CBCT finding. Conversely, the LR− was 0.07, suggesting that a negative CBCT result was strongly associated with the absence of histopathologically confirmed invasion. Collectively, these findings indicate that CBCT demonstrated high sensitivity and good overall diagnostic performance for the preoperative detection of mandibular invasion in patients with OSCC.

Table 7: Diagnostic accuracy of CBCT based on histological findings

Diagnostic parameter	Value
TP	30
TN	24
FP	4

FN	2
Sensitivity	93.8%
Specificity	85.7%
PPV	88.2%
NPV	92.3%
Diagnostic accuracy	90.0%
LR+	6.56
LR−	0.07

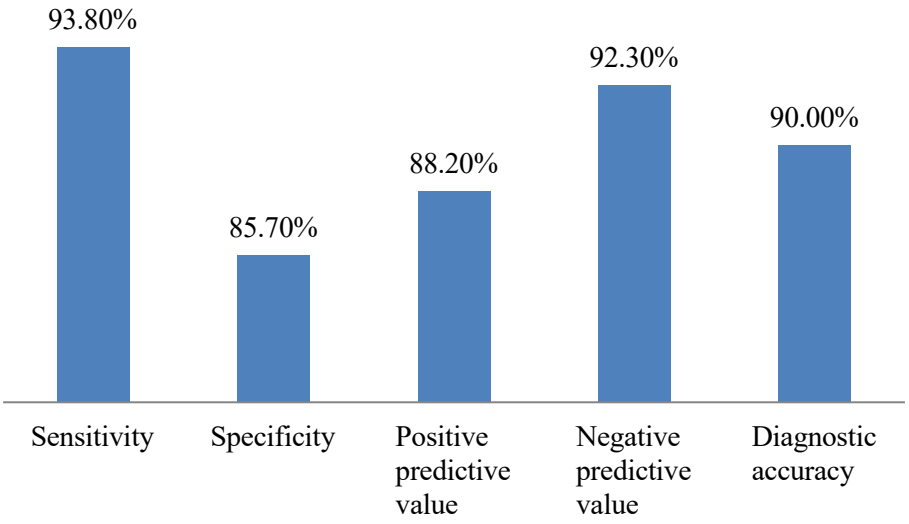

Figure 7: Diagnostic accuracy of preoperative CBCT in detecting mandibular invasion based on histopathological findings

Table 8 & Figure 8 summarize the agreement between preoperative CBCT findings and intraoperative surgical assessment of mandibular involvement. Among the 31 cases with gross mandibular involvement identified during surgery, CBCT correctly detected 29 cases as TP, whereas 2 cases were interpreted as negative, representing FN findings. Of the 29 cases in which no gross mandibular involvement was observed intraoperatively, CBCT correctly classified 24 cases as TN, while 5 cases were incorrectly categorized as positive, representing FP findings. Overall, the preoperative CBCT assessment agreed with the intraoperative surgical findings in 53 of 60 cases (88.3%), demonstrating a high degree of diagnostic concordance. These findings support the usefulness of CBCT as a preoperative imaging modality for assessing mandibular involvement in patients with OSCC.

Table 8: Correlation of surgical findings with CBCT findings

Surgical assessment	CBCT positive for mandibular invasion	CBCT negative for mandibular invasion	Total
Gross invasion present	29 (TP)	2 (FN)	31
Gross invasion absent	5 (FP)	24 (TN)	29
Total	34 (56.7%)	26 (43.3%)	60

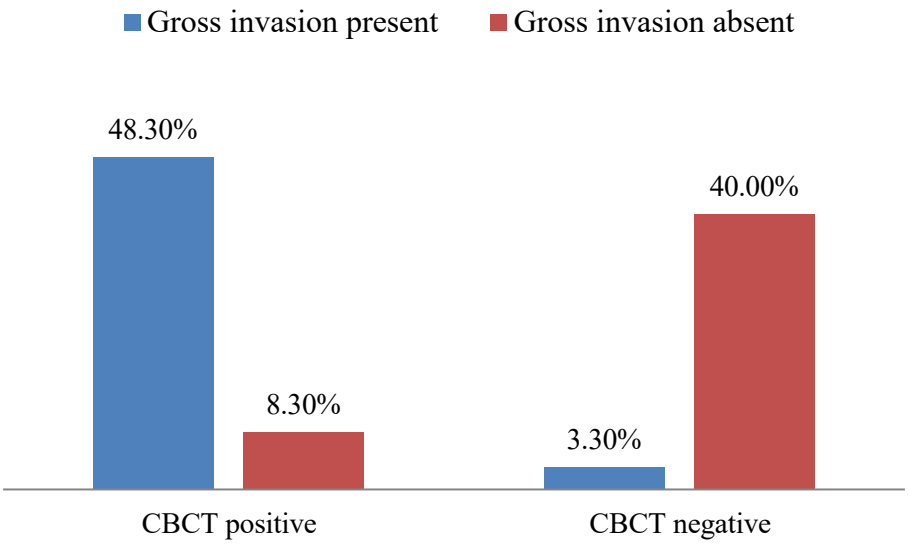

Figure 8: Correlation of preoperative CBCT findings with intraoperative assessment of mandibular involvement in OSCC

Table 9 & Figure 9 summarize the diagnostic performance of CBCT in relation to intraoperative surgical findings, which were considered the reference standard. Of the 31 cases in which gross mandibular invasion were identified during surgery, CBCT correctly detected 29 cases (TP) and failed to identify 2 cases (FN). Among the 29 cases without gross mandibular involvement at surgery, CBCT correctly classified 24 cases as TN, whereas 5 cases were incorrectly interpreted as positive (FP).

The calculated sensitivity was 93.5%, demonstrating the ability of CBCT to detect mandibular invasion when it was confirmed intraoperatively. The specificity was 82.8%, indicating good performance in identifying cases without gross surgical involvement. The PPV was 85.3%, and the NPV was 92.3%. The overall diagnostic accuracy was 88.3%. The LR+ was 5.42, whereas the LR− was 0.08. Collectively, these findings demonstrate that CBCT provides high sensitivity and good diagnostic accuracy for preoperative detection of mandibular invasion, with a negative CBCT result showing particular value in ruling out gross mandibular involvement.

Table 9: Diagnostic accuracy of CBCT based on surgical findings

Diagnostic parameter	Value
TP	29
TN	24
FP	5
FN	2
Sensitivity	93.5%
Specificity	82.8%
PPV	85.3%
NPV	92.3%
Diagnostic accuracy	88.3%
LR+	5.42
LR−	0.08

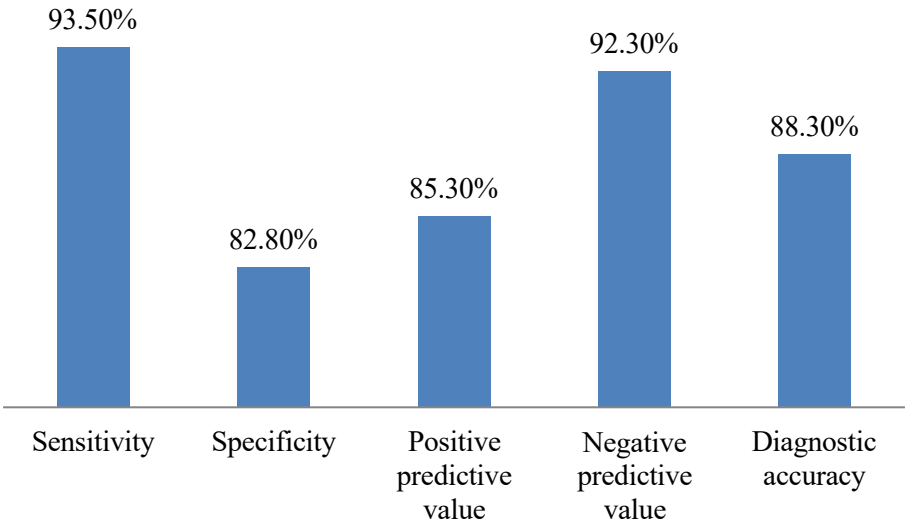

Figure 9: Diagnostic performance of CBCT for mandibular invasion using intraoperative findings as the reference standard

DISCUSSION

Mandibular involvement is an important determinant in the management and prognosis of OSCC, particularly when the primary tumor is located adjacent to the mandible. Accurate preoperative identification of mandibular invasion is essential for determining the extent of surgery and for avoiding both inadequate tumor clearance and unnecessary mandibular resection. Imaging therefore plays a central role in evaluating the relationship between the primary tumor and the underlying bone.

Mukherji et al. (2001) [10] evaluated the role of computed tomography (CT) in detecting mandibular invasion by squamous cell carcinoma of the oral cavity. Their findings demonstrated that CT could provide useful information regarding cortical destruction and the extent of osseous involvement. The study emphasized the value of cross-sectional imaging in preoperative assessment, particularly because clinical examination alone may not reliably determine the depth and pattern of mandibular invasion. These observations support the use of CT as an important component of the diagnostic work-up of patients with OSCC suspected of involving the mandible.

The diagnostic value of different imaging modalities was further investigated by Gu et al. (2010) [11], who compared CT, magnetic resonance imaging (MRI), and ^{18}F-Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography (^18F-FDG PET) /CT for assessment of mandibular invasion. Their study highlighted that each modality provides complementary information. CT is particularly useful for demonstrating cortical and trabecular bone destruction, whereas MRI provides superior visualization of soft-tissue extension and marrow abnormalities. PET/CT may provide additional metabolic information regarding the primary tumor and associated disease. The authors suggested that combining imaging modalities may improve the overall assessment of mandibular involvement compared with relying on a single imaging technique.

In a more recent comparative investigation, Kouketsu et al. (2021) [12] assessed different diagnostic imaging techniques for detecting bone invasion in oral carcinomas. Their findings reinforced the importance of selecting an imaging modality according to the suspected pattern of invasion. The evaluation of bone involvement requires careful assessment of both cortical destruction and medullary extension, as these features may influence surgical planning. Their observations also indicate that no single imaging technique should necessarily be considered sufficient in every clinical situation, and that complementary information from different modalities may improve diagnostic confidence.

The relationship between radiological findings and actual pathological invasion was examined by Huntley et al. (1996) [13] in a CT and histological study of mandibular invasion by OSCC. Their work demonstrated the importance of correlating

radiological evidence with histopathological findings. This correlation is particularly relevant because radiographic abnormalities do not always represent microscopic tumor infiltration. Reactive changes, inflammation, or remodeling may produce imaging findings that can mimic malignant bone involvement. Consequently, interpretation of mandibular invasion should consider the limitations of imaging and the biological behavior of the tumor.

Earlier work by Close et al. (1986) [14] also established the usefulness of CT in evaluating mandibular involvement in intraoral carcinoma. Their study contributed to the recognition that CT could demonstrate the relationship between the tumor and mandibular structures more effectively than conventional clinical assessment alone. The ability to visualize cortical irregularity and areas of bone destruction provides valuable information for determining whether the mandible is likely to require resection. These findings laid an important foundation for the subsequent development and application of modern cross-sectional imaging techniques in oral carcinoma.

The influence of imaging expertise was specifically addressed by Silva et al. (2016) [15], who compared different imaging techniques for pre-surgical evaluation of mandibular bone invasion and examined the relevance of radiologist experience. Their findings emphasized that diagnostic performance is influenced not only by the imaging modality itself but also by the expertise of the clinician interpreting the images. This is particularly important in borderline cases in which subtle cortical defects or early medullary changes may be difficult to distinguish from inflammatory or reactive alterations. Thus, standardized imaging protocols and experienced interpretation can contribute substantially to accurate preoperative decision-making.

Collectively, the findings of these studies indicate that CT remains an important imaging modality for assessment of mandibular invasion in OSCC, particularly because of its ability to demonstrate cortical and osseous destruction. However, MRI may provide additional information regarding marrow and soft-tissue involvement, while ^18F-FDG PET/CT can contribute metabolic and whole-body staging information. Gu et al. (2010) [11] and Kouketsu et al. (2021) [12] therefore support a multimodality approach when the clinical situation requires more comprehensive evaluation.

The differences between radiological and histopathological assessment are also clinically significant. Imaging primarily identifies macroscopic or radiologically apparent bone involvement, whereas histopathology can demonstrate microscopic tumor infiltration. The findings reported by Huntley et al. (1996) [13] emphasize the importance of this distinction. Therefore, a radiological diagnosis of mandibular invasion should be interpreted in conjunction with clinical findings, tumor location, patterns of bone destruction, and, where available, pathological findings.

Another important consideration is the potential effect of mandibular invasion on surgical management. Accurate identification of the extent of bone involvement may assist surgeons in deciding between marginal and segmental mandibular resection and in defining appropriate surgical margins. Overestimation of invasion may result in unnecessarily extensive surgery and increased morbidity, whereas underestimation may compromise oncological clearance. The imaging findings reported by these studies collectively demonstrate why precise preoperative imaging assessment is essential for balancing oncological safety with preservation of mandibular function. Overall, the available evidence demonstrates a progressive improvement in the imaging-based evaluation of mandibular invasion in OSCC. The work of various studies further highlighted the importance of radiologist expertise, and reinforced the need for comparative and multimodality assessment. Thus, optimal evaluation of mandibular invasion should involve careful correlation of clinical examination with appropriate cross-sectional imaging and, whenever possible, histopathological findings. Such an integrated approach can improve preoperative staging, facilitate individualized surgical planning, and potentially reduce both inadequate treatment and unnecessary mandibular morbidity.

LIMITATIONS

This study has several limitations that should be considered when interpreting the findings. First, the study was conducted at a single tertiary care center, which may limit the generalizability of the results to other institutions and patient populations. The retrospective/observational nature of the study may have introduced selection and information bias, particularly because the analysis depended on the availability and quality of existing clinical, radiological, surgical, and histopathological records. In addition, the study population was relatively limited, and larger multicenter studies would be useful to confirm the diagnostic performance of CBCT.

Another limitation is that CBCT primarily provides detailed information regarding osseous structures and may have limited ability to demonstrate subtle soft-tissue extension or early microscopic bone infiltration. Histopathological assessment may also be influenced by the orientation and sampling of surgical specimens. Furthermore, intraoperative assessment of mandibular involvement is based on gross surgical findings and may not always correspond precisely with microscopic tumor extension. Variations in tumor location, size, growth pattern, and degree of bone involvement could also influence CBCT interpretation. Finally, interobserver variability in radiographic assessment was not specifically evaluated, and the findings may therefore require validation using standardized assessment protocols and multiple independent observers.

CONCLUSION

CBCT demonstrates considerable clinical utility in the preoperative evaluation of mandibular invasion in patients with OSCC. Its ability to depict cortical and medullary bone changes can provide important information for determining the extent of mandibular involvement and assisting in surgical planning. Comparison with both intraoperative findings and histopathological assessment indicates that CBCT can provide reliable preoperative information regarding the presence or absence of mandibular invasion. The findings support the incorporation of CBCT into the multimodal preoperative assessment of OSCC**,** particularly when mandibular involvement is suspected. However, CBCT findings should be interpreted alongside clinical examination and other relevant investigations rather than being considered independently. Further prospective, multicenter studies with standardized imaging protocols and assessment by multiple observers are warranted to establish the broader applicability of CBCT and to further define its role in guiding the extent of mandibular surgery.

Conflicts of Interest: Nil

Financial Support: None

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