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METHODS FOR IMPROVING THE DIAGNOSTIC ACCURACY OF MULTISLICE COMPUTED TOMOGRAPHY (MSCT) IMAGES IN ORAL CAVITY AND TONGUE TUMORS

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Abstract
Background: Tumors of the oral cavity and tongue represent a significant diagnostic challenge because of the complex anatomy of the oral region, the close relationship between soft tissues and bone, and artifacts caused by dental restorations. Accurate imaging assessment is essential for determining tumor extent, evaluating regional lymph nodes, establishing clinical stage, and planning appropriate treatment.
Objective: This article aims to analyze the principal methods for improving the diagnostic accuracy of multislice computed tomography (MSCT) in patients with oral cavity and tongue tumors, with particular emphasis on scanning protocols, intravenous contrast enhancement, artifact reduction, multiplanar reconstruction, and standardized radiological interpretation.
Methods: The article presents a narrative review of scientific literature and clinical imaging recommendations concerning computed tomography in oral and head and neck oncology. Published research on image acquisition, reconstruction techniques, dental metal artifacts, and complementary imaging modalities was reviewed and synthesized.
Results: The diagnostic value of MSCT can be improved through optimized acquisition parameters, thin-section reconstruction, appropriate intravenous contrast administration, multiplanar image analysis, and specific techniques for reducing dental artifacts. A standardized reporting approach may further improve the consistency of tumor assessment. Nevertheless, MSCT should be interpreted in conjunction with clinical examination, histopathological findings, and other imaging methods when indicated.
Conclusion: Improving MSCT diagnostic accuracy requires an integrated approach involving technical optimization, knowledge of oral anatomy, systematic image interpretation, and multidisciplinary collaboration. These measures can support more reliable local tumor assessment and treatment planning.
Keywords: multislice computed tomography, MSCT, oral cavity tumors, tongue cancer, diagnostic accuracy, contrast-enhanced CT, dental artifacts, image reconstruction, tumor staging.

1. Introduction

Tumors of the oral cavity and tongue constitute an important group of head and neck neoplasms. Squamous cell carcinoma is the predominant malignant histological type in this anatomical region. Early recognition and accurate determination of tumor extent are essential for selecting treatment strategies, estimating prognosis, and reducing the risk of inappropriate staging.

The oral cavity includes the lips, buccal mucosa, gingiva, floor of the mouth, hard palate, retromolar region, and anterior two-thirds of the tongue. The close anatomical relationships between these structures make the assessment of tumor extension particularly challenging. Malignant lesions may infiltrate adjacent muscles, cross anatomical boundaries, involve the

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mandible or maxilla, and spread to regional cervical lymph nodes. Consequently, diagnostic imaging must provide information about both the primary lesion and the surrounding anatomical structures.

Multislice computed tomography (MSCT), also referred to as multidetector computed tomography (MDCT), is widely used in the assessment of head and neck malignancies. Its main advantages include rapid image acquisition, high spatial resolution, detailed visualization of cortical bone, and the ability to evaluate cervical lymph nodes and adjacent anatomical compartments. Contrast-enhanced CT is considered an appropriate imaging examination for the initial staging of suspected or confirmed oral cavity cancer [1].

However, the diagnostic performance of MSCT may be limited by several factors. Dental fillings, crowns, implants, and other metallic restorations can generate beam-hardening and photon-starvation artifacts. These artifacts may obscure small lesions, distort anatomical boundaries, and complicate the evaluation of tumor infiltration. In addition, patient movement, inadequate contrast enhancement, thick reconstructed sections, and inconsistent interpretation may reduce diagnostic confidence.

Research has demonstrated that additional CT reconstructions obtained at different angles can improve tumor detection when conventional axial images are affected by dental metal artifacts [2]. Furthermore, contemporary reviews emphasize the importance of optimized CT protocols, multiplanar reconstructions, and complementary imaging techniques in the assessment of oral malignancies [3].

The purpose of this article is therefore to examine practical and evidence-informed methods for improving the diagnostic accuracy of MSCT images in oral cavity and tongue tumors.

2. Materials and Methods

This article was prepared as a narrative review of the scientific literature on MSCT and the imaging assessment of oral cavity and tongue tumors. Relevant publications were identified through searches of PubMed-indexed literature, radiological review articles, and clinical imaging recommendations.

The literature review focused on five principal areas:

Technical parameters of MSCT acquisition and reconstruction.

Intravenous contrast enhancement and soft-tissue visualization.

Reduction of artifacts caused by dental materials.

Systematic assessment of primary tumors, adjacent structures, and cervical lymph nodes.

Integration of MSCT with magnetic resonance imaging (MRI), ultrasound, and histopathological examination.

Studies and recommendations concerning initial staging, local tumor extension, and diagnostic limitations were considered particularly relevant. The findings were synthesized descriptively to identify practical approaches that may improve image quality and interpretation.

This article is a narrative literature review rather than an original clinical investigation. No new patient cohort, experimental measurements, or independent sensitivity and specificity estimates were generated. The proposed approaches should be adapted to local equipment, institutional protocols, patient characteristics, and applicable radiation-safety standards.

3. Technical Optimization of MSCT Image Acquisition

3.1. Selection of scanning parameters

Appropriate image acquisition is the first requirement for reliable radiological diagnosis. Modern MSCT systems allow rapid volumetric scanning of the oral cavity and neck, reducing the likelihood of motion-related degradation.

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The acquisition protocol should provide adequate spatial resolution while maintaining radiation exposure at the lowest level reasonably achievable for the diagnostic task. Tube voltage, tube current, automatic exposure control, pitch, collimation, and reconstruction settings should be selected according to the scanner, the patient's body habitus, and the clinical indication.

Thin-section acquisition is particularly important for evaluating small mucosal lesions, subtle cortical erosion, and the relationship between a tumor and adjacent structures. Thin reconstructed sections, commonly around 0.6–1.25 mm when supported by the scanner, can facilitate detailed multiplanar assessment. The exact section thickness should be determined by the clinical question and the available equipment rather than applied as a universal requirement.

Both soft-tissue and bone reconstruction algorithms may be useful. Soft-tissue reconstructions assist in identifying the primary tumor, evaluating tissue enhancement, and assessing lymph nodes. Bone reconstructions provide additional information about cortical destruction, mandibular involvement, and changes in adjacent osseous structures.

It is also important to distinguish acquisition parameters from reconstruction parameters. A thin-section reconstruction can improve the visualization of anatomical detail from appropriately acquired volumetric data, but it cannot restore information that was never captured or eliminate all artifacts.

3.2. Patient positioning and motion control

Correct patient positioning helps improve image consistency and reduce unnecessary artifacts. The head should be positioned symmetrically, with the neck comfortably extended when clinically feasible. The patient should be instructed to remain still during scanning.

Movement of the tongue, swallowing, and changes in head position may create blurring or inconsistencies in anatomical boundaries. Clear instructions immediately before image acquisition can reduce these problems. When appropriate, the radiographer should verify that the scanned field includes the primary lesion and the relevant cervical nodal regions.

For selected mucosal lesions, distending the cheeks by gently puffing them out may separate opposing mucosal surfaces and improve visualization of buccal and gingival abnormalities. This technique should only be used when the patient can perform it comfortably and when it is appropriate for the suspected lesion [3].

3.3. Multiplanar reconstruction

Multiplanar reconstruction (MPR) is an important method for improving the diagnostic interpretation of MSCT images. It enables the radiologist to examine the lesion in axial, coronal, and sagittal planes and to assess its relationship with muscles, the floor of the mouth, the mandible, and other anatomical structures.

Axial images provide a general overview of the lesion and cervical lymph nodes. Coronal images may be particularly useful for assessing superior-inferior extension and relationships with the floor of the mouth. Sagittal reconstructions can help clarify the anterior-posterior extent of a tongue lesion and its proximity to adjacent structures.

Oblique or angled reconstructions may be valuable when metallic dental restorations produce streak artifacts across the region of interest. In a study involving 82 patients with oral or oropharyngeal cancer, the use of additional tilted images increased the average number of detected tumors from approximately 70% to 78% among the readers and contributed to correction of underestimated tumor stages in some patients [2]. These results illustrate the

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potential diagnostic value of complementary reconstructions, although they should not be interpreted as a universal performance estimate for every MSCT system or patient population.

4. Contrast Enhancement and Soft-Tissue Differentiation

Intravenous contrast enhancement is a central component of CT assessment in patients with suspected oral cavity malignancies. It improves the differentiation of enhancing tumor tissue from surrounding structures and helps identify necrotic areas, inflammatory changes, vascular structures, and abnormal lymph nodes.

A contrast-enhanced examination of the neck is recommended for the initial staging of suspected or confirmed oral cavity cancer in appropriate clinical circumstances [1]. Contrast timing should be selected to provide adequate enhancement of the relevant soft tissues and cervical structures.

The contrast agent, volume, injection rate, and acquisition delay must be determined according to the institutional protocol, the scanner, the clinical indication, and the patient's renal function and history of contrast reactions. A fixed injection protocol should not be applied indiscriminately to every patient.

The radiologist should evaluate the lesion's location, dimensions, margins, enhancement pattern, and relationship with adjacent anatomical structures. Irregular or infiltrative margins, heterogeneous enhancement, and areas of necrosis may raise suspicion for malignancy, but none of these findings independently establishes a histopathological diagnosis.

Contrast enhancement also assists in evaluating cervical lymph nodes. Relevant findings include nodal enlargement, round morphology, central necrosis, and suspicious enhancement patterns. Nevertheless, nodal size alone is insufficient to exclude or confirm metastatic involvement. Small metastatic nodes may be present, while enlarged nodes may reflect inflammatory or infectious conditions.

The diagnostic report should therefore distinguish imaging findings that are suspicious for malignancy from those that are definitive only after correlation with clinical or pathological evidence.

5. Reduction of Dental Metal Artifacts

5.1. Mechanisms and diagnostic consequences

Dental metal artifacts are among the most important technical limitations of CT imaging in the oral cavity. Metallic fillings, crowns, bridges, and implants can cause photon starvation, beam hardening, and streak artifacts. These effects may appear as alternating bright and dark bands that obscure adjacent tissues or distort their apparent density.

Artifacts are particularly problematic when the primary lesion is located near the teeth, gingiva, buccal mucosa, or anterior oral cavity. They can obscure tumor margins, conceal small lesions, and complicate the evaluation of mandibular involvement.

A review of CT imaging in oral malignancies highlights the need to recognize these artifacts and consider technical strategies for reducing their effect on diagnostic interpretation [3].

5.2. Practical artifact-reduction techniques

Several complementary methods may be used to reduce the impact of dental artifacts:

First, optimized acquisition geometry. When supported by the scanner and appropriate for the clinical situation, modifying the gantry angle or obtaining additional angled images may help prevent the most severe streaks from crossing the lesion. This approach is supported by research demonstrating improved detection in selected patients with oral and oropharyngeal tumors [2].

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Second, metal artifact reduction algorithms. Many modern CT systems provide dedicated reconstruction algorithms designed to reduce artifacts caused by high-density materials. These algorithms may improve the visibility of structures near dental restorations, although they can sometimes introduce smoothing or secondary artifacts. Images reconstructed with and without these corrections should be compared when the appearance of a lesion remains uncertain.

Third, complementary reconstruction methods. Thin-section images, multiplanar reconstructions, and separate soft-tissue and bone series can help the radiologist examine the affected region from different perspectives.

Fourth, careful assessment of the artifact-affected region. The radiologist should document when an artifact limits visualization of the primary tumor or adjacent tissues. A region that cannot be adequately assessed should not be described as definitively free of disease.

The use of multiple artifact-reduction methods is often more useful than relying on a single technical adjustment. Nevertheless, the effectiveness of any method depends on the scanner, the location and composition of the dental material, and the relationship between the artifact and the lesion.

6. Systematic Assessment of the Primary Tumor and Regional Lymph Nodes

Improving diagnostic accuracy requires more than obtaining technically adequate images. A standardized interpretation strategy is needed to ensure that clinically important findings are not overlooked.

6.1. Assessment of the primary lesion

The radiologist should systematically document the following characteristics:

Anatomical subsite and side of the oral cavity.

Maximum measurable dimensions in appropriate planes.

Tumor margins and enhancement pattern.

Extension into adjacent muscles and anatomical compartments.

Involvement of the floor of the mouth or neighboring soft tissues.

Evidence of cortical bone erosion or destruction.

Relationship with the tongue, mandible, maxilla, and other relevant structures.

Technical limitations, including motion and dental artifacts.

For tongue tumors, the relationship between the lesion and the intrinsic and extrinsic tongue musculature is particularly important. The radiologist should assess the extent of infiltration and whether the tumor approaches or crosses the midline.

The depth of invasion is a clinically important staging parameter in oral tongue cancer. However, it should not be confused with the maximum visible tumor thickness on CT. CT may not reliably distinguish all tumor boundaries from surrounding soft tissues, particularly in small or superficial lesions. MRI and intraoral ultrasound can provide complementary information in selected cases.

MRI generally provides superior soft-tissue contrast and can be useful for assessing the extent of disease, marrow involvement, and suspected perineural spread. CT remains particularly valuable for evaluating cortical bone destruction. The choice of modality should reflect the clinical question and the limitations of each technique [1, 4].

6.2. Assessment of cervical lymph nodes

Regional lymph node evaluation is essential because nodal metastasis may influence prognosis and treatment planning. The examination should include the relevant cervical nodal levels and document suspicious findings such as necrosis, abnormal morphology, irregular margins, and possible extranodal extension.

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A structured assessment reduces the likelihood that a small but suspicious node will be overlooked. At the same time, the radiologist should avoid diagnosing metastasis solely on the basis of node size or a single nonspecific imaging feature.

When findings remain indeterminate, ultrasound-guided sampling, MRI, or additional investigations may be considered according to the clinical context. The final interpretation should integrate imaging findings with physical examination and pathological evidence whenever available.

7. Standardization of Radiological Interpretation

Variation between readers can affect the reproducibility of tumor measurements and staging. Standardized reporting is therefore an important component of improving diagnostic quality.

A structured report should include the primary tumor location, dimensions, local extension, suspected bone involvement, cervical nodal findings, and relevant technical limitations. It should also distinguish clearly between positive findings, negative findings, and structures that cannot be evaluated adequately.

Comparison with previous imaging, when available, can help identify interval changes and support assessment of treatment response or suspected recurrence. Measurements should be performed consistently, using comparable planes and reconstruction methods whenever possible.

Radiologists should also be familiar with the current TNM classification applicable to the tumor site and histological type. Imaging findings contribute to clinical staging, but final staging requires integration with clinical and pathological information. In particular, depth of invasion in oral cavity squamous cell carcinoma may require information that is not reliably obtainable from CT alone.

Multidisciplinary communication between radiologists, oral and maxillofacial surgeons, otolaryngologists, oncologists, and pathologists can help resolve discrepancies between imaging findings and clinical examination. This collaboration is especially important when dental artifacts obscure the lesion or when the suspected extent of disease would substantially change treatment planning.

8. The Role of Artificial Intelligence and Advanced Image Processing

Artificial intelligence (AI) and computer-assisted image analysis are emerging approaches that may support the interpretation of head and neck CT examinations. Potential applications include automated anatomical segmentation, lesion localization, measurement of tumor dimensions, lymph node detection, and identification of image-quality problems.

Deep-learning algorithms may also help reduce noise or metal-related artifacts. However, improved visual appearance does not automatically translate into improved diagnostic accuracy. An algorithm may inadvertently remove subtle pathological information or create structures that resemble disease.

Consequently, AI-generated images and measurements should be evaluated by qualified radiologists rather than accepted without review. Before clinical implementation, systems should undergo appropriate technical validation and assessment using representative patient populations. Their performance should be examined across different scanner manufacturers, acquisition protocols, lesion locations, and degrees of dental artifact.

At present, AI should be considered a supplementary tool rather than a replacement for clinical expertise, histopathological confirmation, or established imaging protocols. Its contribution to diagnostic accuracy must be demonstrated through well-designed clinical studies rather than assumed from technical image-quality improvements alone.

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9. Discussion

The literature indicates that the diagnostic accuracy of MSCT in oral cavity and tongue tumors depends on a combination of technical, anatomical, and interpretative factors. Optimized acquisition protocols provide the foundation for adequate image quality, while contrast enhancement and multiplanar reconstruction facilitate the assessment of the primary lesion and its local extension.

Dental metal artifacts remain a particularly important challenge. Research by Bannas and colleagues demonstrated that additional angled CT images can improve tumor detection and reduce the risk of underestimated staging in selected cases [2]. These findings support the use of alternative reconstruction planes when standard axial images are insufficient.

However, no single technical modification can eliminate every diagnostic limitation. CT may be less effective than MRI for defining certain soft-tissue boundaries or suspected perineural spread. MRI, in turn, can be affected by dental material artifacts and motion, while intraoral ultrasound may be useful for selected superficial lesions and assessment of tongue tumor thickness. The modalities should therefore be regarded as complementary rather than interchangeable.

The available literature also highlights the importance of systematic reporting and clinical correlation. A technically high-quality scan may still yield an incomplete diagnosis if the reader overlooks relevant anatomical spaces, fails to assess cervical lymph nodes systematically, or does not acknowledge limitations caused by artifacts.

Several practical priorities can be identified. Imaging departments should use standardized, indication-specific protocols; provide access to artifact-reduction techniques where available; ensure that radiologists are familiar with oral cavity anatomy and tumor spread; and encourage multidisciplinary review of complex cases. Future studies should assess these interventions using clearly defined diagnostic endpoints, including lesion detection, agreement between readers, staging accuracy, and correlation with histopathology.

Because the present article is a narrative review, it does not provide original quantitative evidence that one combined protocol improves sensitivity or specificity by a particular percentage. Prospective and retrospective clinical studies are required to determine the relative contribution of each optimization method in different patient populations.

10. Conclusion

Improving the diagnostic accuracy of multislice computed tomography in oral cavity and tongue tumors requires a comprehensive approach that combines technical optimization with systematic radiological interpretation. Thin-section reconstruction, appropriate contrast enhancement, multiplanar assessment, and effective reduction of dental metal artifacts can improve the visualization of primary lesions and surrounding anatomical structures.

Standardized reporting, careful assessment of cervical lymph nodes, and explicit documentation of technical limitations further contribute to diagnostic consistency. MRI, ultrasound, and histopathological examination should be incorporated when clinically indicated to address questions that cannot be resolved adequately by MSCT alone.

The most effective diagnostic strategy is therefore not based on a single imaging technique but on the coordinated use of optimized MSCT protocols, complementary diagnostic methods, and multidisciplinary clinical expertise. Further clinical research is needed to quantify the improvement in diagnostic performance associated with individual and combined optimization techniques.

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