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MRI VISUALIZATION OF ORAL CAVITY TUMORS: DIAGNOSTIC FEATURES AND CLINICAL SIGNIFICANCE

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Abstract
Magnetic resonance imaging (MRI) plays an important role in the diagnosis and assessment of oral cavity tumors. Due to its excellent soft-tissue contrast and multiplanar imaging capabilities, MRI provides valuable information about tumor location, size, anatomical boundaries, and involvement of adjacent structures. This article examines the diagnostic potential of MRI in the visualization of oral cavity tumors, focusing on their morphological characteristics, signal intensity patterns, enhancement features, and local extension. Particular attention is paid to the assessment of the tongue, floor of the mouth, buccal mucosa, gingiva, hard palate, and retromolar region. The article also discusses the role of diffusion-weighted imaging, contrast-enhanced sequences, and MRI-based tumor staging. The findings emphasize that MRI is an important imaging method for preoperative assessment, treatment planning, and follow-up of patients with oral cavity malignancies. However, imaging findings should always be interpreted in combination with clinical examination and histopathological results.

Keywords: magnetic resonance imaging, oral cavity tumors, oral cancer, squamous cell carcinoma, soft-tissue visualization, diffusion-weighted imaging, tumor staging, contrast enhancement, radiological diagnosis.

Introduction

Tumors of the oral cavity represent an important group of head and neck neoplasms. They may develop in different anatomical structures, including the tongue, floor of the mouth, buccal mucosa, gingiva, hard palate, and retromolar trigone. Among malignant oral cavity tumors, squamous cell carcinoma is the most common histological type.

Early and accurate diagnosis is essential for determining the appropriate treatment strategy and improving clinical outcomes. Clinical examination and biopsy remain fundamental components of the diagnostic process. However, imaging methods are necessary to evaluate the extent of the tumor, its relationship with surrounding anatomical structures, and possible regional or distant spread.

Magnetic resonance imaging (MRI) is particularly valuable in this context because it provides high-resolution images of soft tissues without using ionizing radiation. Its ability to demonstrate anatomical details in multiple planes makes it useful for evaluating the depth of tumor invasion and involvement of muscles, neurovascular structures, and adjacent spaces.

The purpose of this article is to analyze the role of MRI in the visualization of oral cavity tumors and to describe the main imaging characteristics relevant to clinical diagnosis and treatment planning.

1. Anatomical Structures of the Oral Cavity and Their MRI Assessment

The oral cavity is a complex anatomical region consisting of several interconnected structures. Accurate interpretation of MRI examinations requires detailed knowledge of normal anatomy and the spatial relationships between individual tissues.

The main anatomical regions include:

The anterior two-thirds of the tongue;

The floor of the mouth;

The buccal mucosa;

The upper and lower gingiva;

The hard palate;

The retromolar trigone;

The inner surfaces of the lips.

On MRI, normal muscles, mucosal tissues, fat spaces, glands, and neurovascular structures demonstrate different signal characteristics. These differences help radiologists identify pathological changes and determine the anatomical origin of a lesion.

The tongue is one of the most frequently affected sites of oral cavity malignancy. MRI is particularly useful for evaluating the intrinsic and extrinsic tongue muscles, determining tumor depth, and identifying extension across the midline.

The floor of the mouth is another important region because tumors arising here may extend into the sublingual space, tongue musculature, and adjacent mandibular structures. MRI allows detailed visualization of these soft-tissue relationships.

2. MRI Protocol for Oral Cavity Tumor Visualization

A standardized MRI protocol is essential for obtaining diagnostically useful images. The examination should cover the primary tumor region and relevant surrounding anatomical structures, including regional lymph nodes.

Commonly used MRI sequences include:

T1-weighted imaging. This sequence provides anatomical information and helps distinguish fatty tissues from muscles and other soft-tissue structures. It is useful for identifying the normal anatomical boundaries of the oral cavity.

T2-weighted imaging. T2-weighted sequences are sensitive to changes in tissue water content. Many tumors demonstrate intermediate or increased signal intensity compared with adjacent muscles, although signal characteristics vary according to histological composition and tumor microstructure.

Fat-suppressed T2-weighted imaging. Fat suppression improves the visualization of lesions surrounded by fatty tissue and helps demonstrate edema and soft-tissue infiltration.

Diffusion-weighted imaging (DWI). DWI evaluates the movement of water molecules within tissues. Many malignant tumors demonstrate restricted diffusion due to increased cellularity, which is commonly associated with high signal intensity on high-b-value images and low apparent diffusion coefficient (ADC) values. However, restricted diffusion is not specific to malignancy and must be interpreted in combination with other sequences.

Contrast-enhanced T1-weighted imaging. Intravenous gadolinium-based contrast agents can help identify tumor enhancement, distinguish solid tumor components from necrosis, and assess the relationship between the lesion and surrounding tissues.

The exact protocol should be adapted to the anatomical location, clinical question, patient condition, and technical capabilities of the MRI system.

3. MRI Characteristics of Oral Cavity Tumors

The MRI appearance of oral cavity tumors depends on their histological structure, cellularity, vascularity, and the presence of necrosis or other tissue changes.

3.1. Squamous Cell Carcinoma

Squamous cell carcinoma is the most common malignant tumor of the oral cavity. It frequently develops in the tongue, floor of the mouth, buccal mucosa, and gingiva.

On MRI, squamous cell carcinoma commonly appears as an irregular soft-tissue lesion with intermediate signal intensity on T1-weighted images and variable intermediate-to-high signal intensity on T2-weighted images.

Following contrast administration, the tumor usually demonstrates enhancement, although the pattern may be heterogeneous. Areas of necrosis may show reduced or absent enhancement.

DWI may demonstrate restricted diffusion because of the high cellular density of many squamous cell carcinomas. ADC measurements can provide additional quantitative information, but they should not be used as an independent diagnostic criterion.

MRI is especially important for assessing the depth of invasion in tongue and floor-of-mouth tumors. This measurement has clinical relevance because it contributes to tumor staging and treatment planning.

3.2. Minor Salivary Gland Tumors

Minor salivary glands are distributed throughout the oral cavity, particularly in the palate and other mucosal regions. Tumors arising from these glands may be benign or malignant.

MRI provides information about tumor size, internal structure, margins, and extension into adjacent tissues. Signal characteristics vary according to histological type.

For example, pleomorphic adenomas often demonstrate well-defined margins and relatively high T2 signal intensity. Malignant salivary gland tumors may show irregular margins, heterogeneous signal, and infiltration of surrounding structures. Nevertheless, considerable overlap exists between benign and malignant imaging appearances.
Histopathological examination remains necessary for definitive diagnosis.

3.3. Benign Oral Cavity Tumors

Benign tumors may include vascular lesions, neural tumors, fibrous lesions, and other soft-tissue neoplasms.
MRI can help characterize these lesions by demonstrating their location, boundaries, internal composition, and relationship with adjacent anatomical structures.
Well-defined margins may suggest a non-invasive growth pattern, while infiltrative margins may raise suspicion of malignancy. However, margin characteristics alone are insufficient to establish a definitive diagnosis.

4. Assessment of Tumor Extension and Adjacent Structures

One of the main advantages of MRI is its ability to demonstrate the local extent of oral cavity tumors.
The radiological assessment should include:

Tumor dimensions in three anatomical planes;

Depth of invasion;

Involvement of intrinsic and extrinsic tongue muscles;

Extension into the floor of the mouth;

Involvement of the sublingual and submandibular spaces;

Relationship with the mandible and maxilla;

Possible perineural spread;

Regional lymph node involvement.

Tumors of the tongue may extend into adjacent muscles and cross the midline. Lesions of the floor of the mouth may involve the sublingual space and approach the mandible.
MRI is valuable for evaluating soft-tissue involvement. However, computed tomography (CT) may provide complementary information when detailed assessment of cortical bone destruction is required.

Perineural spread is another important feature in selected oral cavity malignancies. MRI, particularly contrast-enhanced imaging, can help identify abnormal nerve enhancement, nerve enlargement, and extension along relevant anatomical pathways.

5. Diffusion-Weighted MRI and Its Diagnostic Value

Diffusion-weighted imaging has become an important complementary technique in head and neck MRI.

DWI is based on the sensitivity of MRI signal to the microscopic movement of water molecules. In tissues with high cellular density, the movement of water may be restricted, resulting in altered diffusion signal characteristics.

The apparent diffusion coefficient provides a quantitative estimate of water diffusion. Many malignant tumors demonstrate relatively low ADC values compared with some benign lesions. However, ADC values may overlap between different tumor types and can be influenced by technical parameters, inflammation, necrosis, and tissue composition. Therefore, DWI should be interpreted alongside conventional anatomical sequences and contrast-enhanced imaging.

DWI may also be useful in treatment response assessment. Changes in diffusion characteristics during or after therapy can provide additional information about tissue response, although interpretation requires standardized protocols and clinical correlation.

6. MRI in Tumor Staging and Treatment Planning

Accurate tumor staging is essential for selecting appropriate treatment. MRI contributes to the assessment of the primary tumor and surrounding soft tissues, while clinical examination, histopathology, and other imaging methods provide additional staging information.

In oral cavity cancer, the TNM classification is commonly used to describe:

T (Tumor): the size and local extent of the primary tumor;

N (Nodes): the involvement of regional lymph nodes;

M (Metastasis): the presence or absence of distant metastases.

MRI findings can help determine the anatomical extent of the primary tumor, including depth of invasion and involvement of adjacent structures. Regional lymph nodes can also be evaluated according to their size, shape, internal architecture, and signal characteristics.

Nevertheless, imaging cannot reliably identify every microscopic metastasis. Histopathological assessment may be required for definitive evaluation of lymph node status.

MRI findings are important for preoperative planning, particularly when the tumor is located near the tongue muscles, floor of the mouth, major neurovascular structures, or adjacent anatomical spaces.

7. Advantages and Limitations of MRI

MRI has several important advantages in the evaluation of oral cavity tumors:

Excellent soft-tissue contrast;

Multiplanar imaging capabilities;

Absence of ionizing radiation;

Assessment of tumor extent and depth of invasion;

Evaluation of adjacent muscles and anatomical spaces;

Possibility of combining anatomical, diffusion-weighted, and contrast-enhanced sequences.

Despite these advantages, MRI also has certain limitations. Patient movement and swallowing may produce artifacts that reduce image quality. Dental restorations and metallic materials can cause susceptibility artifacts, particularly in the oral cavity.

MRI may also have limited sensitivity for subtle cortical bone changes compared with CT. Furthermore, inflammatory lesions and benign tumors may demonstrate imaging characteristics that overlap with those of malignant tumors.

For these reasons, MRI findings should be interpreted in the context of clinical examination, endoscopic assessment when appropriate, histopathological results, and complementary imaging studies.

Conclusion

Magnetic resonance imaging is an important diagnostic method for the visualization and assessment of oral cavity tumors. Its high soft-tissue contrast and multiplanar imaging capabilities allow detailed evaluation of tumor location, dimensions, depth of invasion, and involvement of adjacent anatomical structures.

Conventional T1- and T2-weighted sequences, fat-suppressed imaging, diffusion-weighted imaging, and contrast-enhanced sequences provide complementary diagnostic information. These techniques are particularly useful in the assessment of squamous cell carcinoma, minor salivary gland tumors, and other soft-tissue lesions of the oral cavity.

MRI contributes significantly to preoperative assessment, tumor staging, treatment planning, and follow-up. However, it cannot replace biopsy and histopathological examination. The most reliable diagnostic approach involves the integration of clinical findings, MRI characteristics, and pathological confirmation.

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