

# Comprehensive Review on the Etiology and Early Detection Methods of Oral Cancer

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**Abstract:** Oral cancer is a prevalent malignant tumor with a multifaceted etiology, often detected at advanced stages, thus hindering treatment efficacy. This comprehensive review aims to elucidate the etiology and early detection methods of oral cancer to enhance understanding of the disease's characteristics and recent research progress. Genetic factors, environmental exposures, and lifestyle choices are pivotal in oral cancer pathogenesis. Mutations in genes like TP53, EGFR, and p16INK4a are pivotal, alongside environmental factors like tobacco and alcohol consumption, chronic inflammation, and HPV infection. Early detection is paramount for effective treatment, with emerging methods including serum, salivary, and tissue markers, and advanced imaging techniques such as oral endoscopy and CT scans. An in-depth comprehension of oral cancer pathogenesis and diverse early detection methods promises improved diagnosis rates, better treatment options and enhanced survival and quality of life for patients.

**Keywords:** Oral Cancer; Etiology; Early Detection Methods; Oral Medicine

## 1. Introduction

Oral cancer, as a severe malignant disease, has shown an increasing trend in clinical cases, drawing widespread attention due to its high invasiveness and potential lethal risks [1]. Faced with its escalating health threat, gaining in-depth insights into the etiology of oral cancer and enhancing the precision of early detection has become one of the crucial directions in current medical research. This article aims to provide a comprehensive review of the etiology and early detection methods of oral cancer, with the goal of obtaining a comprehensive understanding of the essence of this disease and the latest research

advancements.

Oral cancer refers to tumors occurring in the oral cavity, including the lips, tongue, buccal mucosa, floor of the mouth, gums, hard palate, and the base of the mouth [2]. Its incidence has been on the rise, making it one of the common cancers globally. Key risk factors associated with it include tobacco use, alcohol consumption, chronic oral irritation, chronic inflammation, and infection with human papillomavirus (HPV) [3]. The high invasiveness and local complexity of oral cancer increase the difficulty of treatment, making early diagnosis a key factor in improving the success rate of patient treatment. The etiology of oral cancer is extremely complex, involving factors such as genetics, environment, and lifestyle. Genetic factors play a crucial role in its development, with mutations in genes, chromosomal abnormalities, and epigenetic changes closely associated with the progression of oral cancer. Abnormal expression of key genes such as TP53, EGFR, and p16INK4a has become a hotspot in oral cancer research [4]. Additionally, environmental factors such as tobacco use and alcohol consumption exacerbate damage and malignancy of the oral mucosa through interaction with genetic factors [5]. In recent years, HPV infection has also garnered significant attention, playing a positive role, particularly in the pathogenesis of oropharyngeal cancer [6].

Early detection of oral cancer is crucial for improving the success rate of treatment. Due to its prolonged course, early lesions often exhibit reversibility, making early discovery and timely intervention significantly enhance the patient's survival rate and quality of life. However, traditional detection methods have certain limitations, necessitating the development of more precise and sensitive early detection methods.

In this context, this article conducts an in-

depth analysis of the etiology and early detection methods of oral cancer, aiming to provide a comprehensive theoretical basis for future clinical practice and research. Through a comprehensive review of oral cancer, we hope to better understand its development process, provide a scientifically rational basis for prevention and treatment efforts, and propel research in the field of oral cancer to new heights.

## 2. Literature Review

Through a review of past relevant studies, theoretical foundations and research backgrounds can be provided for current research. In the comprehensive review of the etiology and early detection methods of oral cancer, the task of literature review is to fully understand existing knowledge, highlight controversies or unsolved mysteries in the field, and emphasize the contributions of previous research in the etiological mechanisms.

In past research, the etiology of oral cancer has always been a focal point in the academic community. Early studies mainly focused on the genetic level, and the abnormal expression of key genes such as TP53, EGFR, and p16INK4a in relation to oral cancer has sparked widespread interest [4]. Various studies have indicated that these genes play a crucial role in the occurrence and development of tumors, providing important clues for the molecular mechanisms of oral cancer.

However, this field still faces a series of controversies and unsolved mysteries. For example, different studies may have inconsistent views on the specific roles of key genes, and there are discrepancies in further verifying the exact etiological mechanisms of oral cancer [7]. These controversies and unsolved mysteries constitute knowledge gaps in the field of the etiology of oral cancer, requiring further in-depth research to address.

Despite the controversies, existing studies have laid an important foundation for understanding the etiology of oral cancer. Through in-depth exploration of changes in key genes, regulation of cell signaling pathways, and other discoveries, researchers have gradually revealed some core mechanisms in the development of oral cancer. These contributions provide strong support for subsequent research, laying the groundwork for a better understanding of the etiology of

oral cancer.

In literature review, the retrospective analysis of past research is not only a tribute to the efforts of predecessors but also guides current research directions. By emphasizing the contributions of existing research and addressing existing issues, the literature review provides a solid foundation for in-depth research into the etiology and early detection methods of oral cancer.

## 3. Early Detection Is the Method of Oral Cancer

Early detection is a crucial component of oral cancer management, and effective early identification can significantly improve treatment success rates and patient survival rates [8]. Currently, various methods for early detection of oral cancer exist, covering a range of technological approaches.

### (1) Serum Biomarker Detection:

Serum biomarkers involve assessing changes in specific molecules in a patient's blood to determine if they have oral cancer [9]. These biomarkers may include specific proteins, antibodies, or other biomolecules. Serum biomarker detection is non-invasive and easy to perform, making it suitable for large-scale screening. However, further research is needed to determine which serum biomarkers have higher sensitivity and specificity in the early diagnosis of oral cancer.

### (2) Salivary Biomarker Detection:

Molecular information in saliva is also widely used for early detection of oral cancer [10]. Salivary biomarker detection methods have the advantages of being non-invasive and convenient, and changes in potential biomarkers in saliva can reflect the status of the oral mucosa. This includes specific proteins, RNA, DNA, etc. However, stability, standardization issues, and the correlation with other physiological and environmental factors still require more in-depth research.

### (3) Imaging Techniques Detection:

Imaging techniques such as intraoral endoscopy, computed tomography (CT), magnetic resonance imaging (MRI), etc., play a crucial role in the early detection of oral cancer [11]. These techniques can visually display morphological and structural changes in oral tissues, helping doctors identify potential lesions. However, these methods still have some limitations in terms of specificity

and sensitivity, and some methods are more invasive.

(4) Analysis of Advantages and Disadvantages: Each early detection method has its unique advantages and limitations. Serum and salivary biomarker detection have the advantages of being non-invasive and convenient, but their accuracy and standardization still need further improvement. Imaging techniques offer visual insights but are constrained by specificity and sensitivity, and some methods are more invasive. The current challenges mainly focus on improving the accuracy of detection methods, reducing false-positive rates, discovering more specific biomarkers, and better integrating these methods in clinical practice.

In future research, emphasis should be placed on exploring the combined application of different detection methods to enhance the overall accuracy and effectiveness of early detection. Additionally, there is a need to intensify in-depth research on potential biomarkers to identify more reliable biological indicators, providing stronger support for the early detection of oral cancer.

#### 4. Conclusion

We have conducted a comprehensive review of the pathogenic mechanisms and early detection methods of oral cancer, aiming to deepen our understanding of this crucial field. Through a thorough analysis of existing research, we have derived a series of key findings and perspectives, providing valuable insights for future studies on oral cancer. The comprehensive review of the pathogenic mechanisms of oral cancer reveals the complexity and diversity of this field. Factors such as abnormal gene expression at the genetic level, the influence of environmental factors, and the regulation of cellular signaling pathways collectively form a complex network underlying the development of oral cancer. Previous research has made significant achievements in the discovery of key genes and the identification of environmental factors, contributing to a profound understanding of the pathogenic mechanisms of oral cancer.

The comprehensive review of early detection methods highlights the diverse landscape of the current field of early diagnosis of oral cancer. Various detection methods, including serum biomarker detection, saliva biomarker

detection, and imaging techniques, each demonstrate their own advantages in different aspects, providing a diverse array of choices for the early detection of oral cancer. However, each method has its limitations and challenges, necessitating continuous research and innovation to further enhance their accuracy and practicality.

Building upon this comprehensive review, this study proposes several directions for future research on oral cancer. Firstly, there is a need to strengthen in-depth research on controversial issues in the pathogenic mechanisms of oral cancer, further clarifying the roles of key genes and the impact of environmental factors, thus filling in relevant knowledge gaps. Secondly, efforts should be made to enhance integrated research on the application of different early detection methods, improving the overall efficiency of early diagnosis through the combined use of multiple approaches. Additionally, future research should focus on exploring new biomarkers and advanced technologies to enhance the accuracy and foresight of early detection of oral cancer. This study, through its comprehensive review of the pathogenic mechanisms and early detection methods of oral cancer, establishes a solid foundation for the in-depth development of research in the field of oral cancer. We hope that these findings will guide future research, driving significant progress in the field of oral cancer and providing more effective treatment and care for patients.

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