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Review Article

Assessment of Oral Microbiota and Its Correlation with Gut Health: A Multidisciplinary Approach

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ABSTRACT:
The human oral cavity harbors a diverse microbiome that plays a crucial role not only in oral health but also in systemic wellbeing. Recent studies have highlighted a significant interplay between oral and gut microbiota, emphasizing the oral-gut axis as a critical pathway influencing immune responses, metabolic functions, and disease progression. This review explores the composition, diversity, and dysbiosis of oral microbiota and their potential translocation to the gut, contributing to gastrointestinal and systemic conditions such as inflammatory bowel disease, metabolic disorders, and even neurodegenerative diseases. A multidisciplinary approach integrating microbiology, immunology, gastroenterology, and dentistry is essential to understand this complex interrelationship. Advanced sequencing technologies, metagenomics, and microbiome-based diagnostics offer promising avenues for early detection and therapeutic intervention. Understanding the oral-gut microbiota continuum opens new possibilities for precision medicine, highlighting the importance of maintaining oral health for overall systemic balance.
Keywords: Oral microbiota, gut microbiota, oral-gut axis, microbiome dysbiosis, systemic health, inflammatory diseases, metagenomics, oral health, gut health, microbial translocation

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INTRODUCTION

The human microbiome, a complex and dynamic collection of microorganisms inhabiting various body sites, plays a vital role in maintaining health and preventing disease. Among these, the oral cavity is considered one of the most diverse microbial ecosystems, comprising over 700 species of bacteria along with fungi, viruses, and archaea (1). While traditionally studied within the confines of oral diseases such as caries and periodontitis, emerging evidence indicates that oral microbiota can influence distant organ systems, particularly the gastrointestinal tract, through a bidirectional interaction known as the oral-gut axis (2,3).

The oral and gut microbiomes share overlapping microbial populations, and dysbiosis in the oral cavity has been linked to systemic inflammatory conditions, including inflammatory bowel disease (IBD), colorectal cancer, and metabolic syndrome (4,5). Microbial translocation from the oral cavity to the gut, facilitated by saliva swallowing and compromised gut barrier function, may allow pathogenic oral microbes such as *Fusobacteriumnucleatum* and *Porphyromonasgingivalis* to colonize the gut and disrupt intestinal homeostasis (6,7).

Understanding the oral-gut microbiota connection requires a multidisciplinary approach involving dentistry, microbiology, gastroenterology, and immunology. Recent advances in high-throughput sequencing, metagenomics, and metabolomics have enabled researchers to characterize microbial communities with unprecedented detail, paving the way for microbiome-targeted diagnostics and therapeutics (8,9).

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The oral microbiome plays a critical role in shaping the host immune response, not only locally within the oral mucosa but also systemically. Oral pathogens can modulate host immunity by producing virulence factors, altering cytokine expression, and influencing the activity of immune cells such as macrophages and dendritic cells (11). These immune alterations may prime the gut environment for inflammatory conditions and even contribute to immune-mediated diseases. The immunological cross-talk between oral and gut tissues is therefore a key area of interest in current microbiome research.

Additionally, lifestyle factors such as diet, smoking, alcohol consumption, oral hygiene practices, and antibiotic use have a profound impact on both oral and gut microbiota composition (12). These factors may act synergistically to promote microbial dysbiosis in both environments, further amplifying disease risk. For example, a high-sugar diet promotes acidogenic bacteria in the mouth and also fosters an inflammatory gut environment, highlighting the systemic impact of nutritional habits. Thus, addressing lifestyle factors is essential when considering interventions targeting the oral-gut axis.

Finally, the development of probiotics and other microbiome-modulating therapies presents a promising avenue for promoting both oral and gastrointestinal health. Certain probiotic strains have demonstrated efficacy in reducing oral biofilm formation, gingival inflammation, and halitosis, while also restoring gut microbial balance and enhancing mucosal immunity (13). Such dual-acting interventions underscore the therapeutic potential of viewing the human microbiome as a connected ecosystem rather than isolated niches. Continued interdisciplinary research will be vital in translating these findings into clinical practice.

This review aims to provide a comprehensive overview of the composition and function of the oral microbiota, its interaction with gut microbiota, and the implications of this relationship for systemic health. It emphasizes the need for integrative strategies to maintain microbiota balance and prevent disease progression through early microbial assessment and targeted interventions.

REVIEW

The human microbiome, a complex and dynamic collection of microorganisms inhabiting various body sites, plays a vital role in maintaining health and preventing disease. Among these, the oral cavity is considered one of the most diverse microbial ecosystems, comprising over 700 species of bacteria along with fungi, viruses, and archaea (1). While traditionally studied within the confines of oral diseases such as caries and periodontitis, emerging evidence indicates that oral microbiota can influence distant organ systems, particularly the gastrointestinal tract, through a bidirectional interaction known as the oral-gut axis (2,3,4).

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Understanding the oral-gut microbiota connection requires a multidisciplinary approach involving dentistry, microbiology, gastroenterology, and immunology. Recent advances in high-throughput sequencing, metagenomics, and metabolomics have enabled researchers to characterize microbial communities with unprecedented detail, paving the way for microbiome-targeted diagnostics and therapeutics (9,10).

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2. Composition and Diversity of the Oral Microbiota The oral cavity encompasses several distinct ecological niches, including the tongue, teeth, gingival crevices, hard and soft palates, and buccal mucosa, each supporting unique microbial communities (11). Dominant genera in the oral cavity include *Streptococcus*, *Actinomyces*, *Veillonella*, *Fusobacterium*, *Prevotella*, and *Porphyromonas* (12).

Factors influencing the oral microbiota composition include age, diet, oral hygiene, salivary flow, antibiotic usage, and systemic health conditions (13). A balanced oral microbiome is essential for preventing pathogenic overgrowth and maintaining mucosal immunity. Dysbiosis, characterized by a shift in microbial balance, is often associated with the onset of oral diseases such as dental caries, periodontitis, and oral mucositis (14).

3. The Gut Microbiota and Systemic Health The gut microbiota comprises trillions of microorganisms that perform vital functions such as digestion, nutrient absorption, immune modulation, and protection against pathogens (15). Major phyla include Firmicutes, Bacteroidetes, Actinobacteria, and Proteobacteria (16).

Gut dysbiosis has been linked to numerous systemic disorders, including obesity, type 2 diabetes, cardiovascular diseases, and neurodegenerative conditions like Alzheimer's and Parkinson's diseases (17,18). The gut-brain axis and gut-liver axis are well-studied pathways through which the gut microbiota influences systemic physiology (19).

Oral-Gut Axis: Mechanisms of Interaction The oral-gut axis refers to the continuous and dynamic interaction between oral and intestinal microbiomes. Saliva is swallowed approximately 600–1000 times per day, introducing oral microbes into the gastrointestinal tract (20).

Microbial translocation occurs when oral bacteria overcome gastric acid barriers and colonize the intestinal mucosa, potentially leading to inflammation and mucosal disruption. *Fusobacteriumnucleatum*, commonly associated with periodontitis, has been isolated from the colonic mucosa in patients with colorectal cancer (21). Similarly, *Porphyromonasgingivalis* is known to induce gut dysbiosis and exacerbate inflammatory responses (22).

Role of Oral Dysbiosis in Gastrointestinal Diseases Oral dysbiosis has been implicated in the pathogenesis of several gastrointestinal disorders. Inflammatory bowel disease (IBD) patients often exhibit elevated levels of oral-origin bacteria such as *Veillonella*, *Fusobacterium*, and *Campylobacter* in their gut microbiota (23).

Mechanistically, these microbes may influence gut immunity through Toll-like receptor activation, Th17 cell differentiation, and disruption of tight junction proteins (24). Clinical studies have also demonstrated a higher prevalence of periodontitis in patients with Crohn's disease and ulcerative colitis, suggesting a bidirectional relationship (25).

Microbiome-Based Diagnostic and Therapeutic Approaches Advances in next-generation sequencing (NGS), metagenomics, and metabolomics have transformed our understanding of microbiota-related diseases. Salivary and fecal microbial profiling may serve as non-invasive biomarkers for early disease detection (26).

Therapeutic strategies targeting oral and gut microbiota include probiotics, prebiotics, dietary interventions, and fecal microbiota transplantation (FMT). Probiotics such as *Lactobacillus* and *Bifidobacterium* strains have shown promise in restoring microbial balance and alleviating gastrointestinal inflammation (27, 28).

Implications for Multidisciplinary Healthcare Given the interconnectedness of oral and gut health, collaboration among dental professionals, gastroenterologists, microbiologists, and immunologists is crucial. Preventive dental care and management of periodontal disease may reduce systemic inflammatory burden and improve gastrointestinal outcomes (29).

Integrating oral health into primary care and chronic disease management frameworks can enhance overall health outcomes. Public health strategies should focus on education, early screening, and lifestyle modification to support microbiota homeostasis (30).

Future Directions and Research Gaps Despite growing evidence supporting the oral-gut microbiota axis, several gaps remain. Longitudinal studies are needed to establish causality and temporal relationships. More research is required to identify specific microbial signatures predictive of disease progression and treatment response (31).

Personalized microbiome-based interventions, tailored to individual microbial profiles, represent a promising frontier in precision medicine. Additionally, the impact of emerging technologies such as artificial intelligence and machine learning on microbiome research warrants exploration Nowadays cancer is the second main cause of death in the world. It is estimated that in 2018 about 9.6 million people will have died from cancer. The most known bacterial carcinogen is Helicobacter pylori. Pathogens that can have an impact on cancer development in the gastrointestinal tract are also found in the oral cavity. Cancer of the oral cavity is one of the most common malignancies. Patients with "recurrent or metastatic head and neck squamous cell carcinoma" (HNSCC) have had a poor prognosis. Oral cancer is increased in smokeless tobacco users.(32- 37)

Conclusion The oral and gut microbiota are intricately linked through a complex network of microbial, immunological, and metabolic interactions. Disruptions in oral microbiota can have far-reaching consequences on gut health and systemic disease development. A multidisciplinary approach is essential to unravel these connections and develop integrated strategies for prevention, diagnosis, and treatment. By recognizing the oral cavity as a gateway to systemic health, clinicians and researchers can work collaboratively to improve patient outcomes and advance the field of microbiome science.

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