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Microbial world in your mouth - understanding the connection to oral diseases.

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Abstract

Oral health is an integral part of overall health, and maintaining a healthy oral microbiome is key to preventing oral diseases. The mouth is home to a diverse community of microorganisms that play a crucial role in maintaining oral health, but an imbalance in this community can lead to the development of oral diseases such as dental caries, periodontal disease, and even oral cancer. Understanding the connection between the oral microbiome and oral diseases is crucial for developing effective prevention and treatment strategies. This article provides an overview of the microbial world in the mouth, including the different types of bacteria, fungus, viruses and protozoa that inhabit the oral cavity and how imbalances in the oral microbiome can contribute to oral diseases. By understanding the complex relationship between the oral microbiome and oral diseases, individuals can take proactive steps to maintain optimal oral health and prevent the development of oral diseases.

Keywords: Oral Microbiome, Microbial Dysbiosis, Oral Disease, Oral Cancer, Oral Squamous Cell Carcinoma

Introduction

The human oral micro bio me is a complex and intricate community of microorganisms, with over 700 different types of microbes present in the mouth[1]. This microbial community is vital to oral health, as oral disease pro cases are closely linked to the presence of bacteria, fungus, viruses, and protozoa[2].

A delicate balance is maintained between the host and the oral micro biome through symbiotic communication and regulatory systems, leading to homeostatic equilibrium[3]. However, dysbiosis of the oral micro bio me can lead to various oral infectious diseases.[4]

In recent years, there has been growing interest in understanding the complex inter actions between the human host and the oral micro bio me, and how these inter actions impact our health[5]. Advances in technology have allowed scientists to explore the oral micro bio me in greater detail than ever before, providing new insights

into the factors that influence its composition and function. In this article, we will delve into the microbial world in your mouth and explore its connection to some common oral diseases.

Healthy oral microbiome

The oral micro bio me is a fascinating and complex ecosystem of micro-organisms that reside in the human oral cavity. Coined by Joshua Lederberg, the term "microbiome" describes the unique community of com mensal, mutualistic, and pathogenic microorganisms that live within us, and play a critical role in determining our overall health and disease susceptibility [6]. The average temperature of the oral cavity remains stable at 37°C, providing a consistent environment for bacterial survival without significant fluctuations. Saliva also maintains a stable pH level of 6.5-7, which is conducive to the growth of most bacterial species. In addition to keeping bacteria hydrated, saliva facilitates the trans portation of nutrients to micro-organisms and plays a vital role in modifying their metabolism and facilitating their attachment to oral surfaces. While the oral cavity maintains a moist environment, consistent temperature, and neutral pH, it is a highly complex and diverse ecosystem that encompasses a wide variety of anatomical structures. Each structure provides a unique physicochemical environment that supports the growth of specific microbial populations, resulting in a heterogeneous and dynamic oral microbiome[7]. From the teeth and tongue to the cheeks, gingival sulcus, hard and soft palate, the oral cavity provides a wide variety of habitats that support the growth of diverse microorganisms[8,9]. In fact, over 700 bacterial species have been identified in the human oral cavity using conventional and culture-independent genetic methods[10]. This diverse microbial population includes some of the most prevalent bacterial species in the human mouth, such as Streptococcus mutans, Porphyromonas gingival is, Staphylococcus, and Lac to bacillus[11]. However, the oral microbiome is not limited to bacteria alone. It also contains a range of other microbes, including protozoa, fungi, and viruses, which further contribute to the dynamic nature of this complex ecosystem[12].

The two most prevalent protozoa, Entamoeba gingival is and Trichomonas Tenex, are primarily saprophytic[13]. Ghannoum et al. reported 85 fungal taxa after con ducting culture-independent research on 20 healthy hosts. The most prevalent species found belonged to the genus Candida, Aspergillus, Fusarium, Cladosporium, Saccharomycetales, Aureo basidium and Crypto coccus [14]. However, the virome of the human oral cavity has not been extensively studied in comparison to its bacterial counterparts. One of the most prevalent eukaryotic viruses in the oral cavity is the herpesvirus, with human herpesvirus (HHV) being the most common. Studies have shown that HHV can establish lifelong latency in the oral cavity and can reactivate in response to various triggers, such as stress, hormonal changes, and immunosuppression. In addition to herpes viruses, papilloma viruses, human immunodeficiency virus, human T-lymphotropic virus (HTLV)have also been identified in the oral microbiome[15].

Following are the major bacterial genera that are present in a healthy oral microbiome:[16]

Table 1: Gram positive bacteria

Cocci	Abiotrophia, Pepto streptococcus, Strep to coccus, Stoma to coccus
Rods	Actinomyces, Bifidobacterium, Coryne bacterium, Eubacterium, Lactobacillus, Propionic bacterium, Pseudo ramibacter, Rothia.

Table 2: Gram negative bacteria

Cocci	Moraxella, Neisseria, Veillonella
Rods	Campylobacter, Capnocytophaga, Desulfobacter, Desulfovibrio, Eike Nella, Fuso bacterium, Hemophilus, Leptotrichia, Prevotella, Selemonas, Simonsiella, Treponema, Wolin Ella.

Functions of healthy oral microbiome

The oral micro bio me, which typically exists in the form of a bio film, is essential for maintaining oral homeostasis and preventing disease development.

Its functions extend beyond oral health and contribute to critical physio logical, metabolic, and immunological processes throughout the body[17]. One important function of the oral microbiome is its role in the digestion of food and nutrient absorption. The micro biome contains many species of bacteria that produce enzymes that break down complex carbo hydrates and other nutrients that are difficult for the host to digest. These bacteria help to extract nutrients from food and make them available for absorption by the host[18].In addition to its role in digestion, the oral microbiome also contributes to energy generation and metabolic regulation[19]. The oral micro biome also plays a critical role in the differentiation and maturation of the host mucosa and its immune system. Many bacteria interact with host cells and stimulate the development of immune cells. This interaction helps to ensure that the host's immune system is properly regulated and can respond appropriately to invading pathogens [20].

Furthermore, the oral micro bio me processes detoxifies environ mental chemicals, contributing to the body's overall detoxification process[21]. It also helps to maintain the barrier function of the skin and mucosa, preventing the invasion of harmful microorganisms [22]. Additionally, the oral micro bio me pro motes colonization resistance, preventing the growth and invasion of disease-causing micro organisms[23].

Oral microbiome and oral diseases

Oral microbiota refers to the complex community of micro-organisms that inhabit the oral cavity. These micro-organisms play a critical role in maintaining oral health, but they can also contribute to the development of a range of oral diseases. Oral diseases such as dental caries, gingivitis and Periodontitis have been consistently linked to alterations in the oral micro bio me. Emerging evidence suggests that changes in the oral microbiota can serve as a potential biomarker for the diagnosis of various oral diseases[24].

Dental caries also known as tooth decay, is caused by oral bacteria fermenting carbohydrates, which produces acid that can dissolve tooth structure and lead to cavities. Consuming high levels of carbo hydrates frequently can lead to a sustained fall in pH, which in turn changes the composition of the oral microbiota to favour the aciduric species[25]. It has long been believed that Streptococcus mutans is the major pathogen of dental caries [26].

There are several other bacterial species, including Bifido bacterium, Propionibacterium, Strep to coccus Salivarius, Strep to coccus oral is, Strep to coccusmilleri, Enterococcus faecalis, A naeslundi, A viscos us, and A Israeli, that have been isolated from sites with dental caries.

These species have been found to play a significant role in the development and progression of dental caries [27]. Periodontitis is a prevalent chronic inflammatory condition that can gradually lead to the destruction of the supporting structures of teeth, making it the sixth most common disease globally [28]. Research has established a clear connection between the oral micro bio me and severe Periodontitis, which is characterized by the presence of the "red complex" bacteria - Porphyromonas

gingival is, Tannerella forsythia, and Treponema denticola [29].

In addition to these bacteria, several other predominant bacterial species contribute to the development of Periodontal disease. These include Aggregatibacter actinomycetemcomitans, Prevotella inter media, Fuso bacterium nucleatum, and Eike Nella corrodens.[30]

The third oral disease that deserves significant attention is oral cancer. There is mounting evidence that members of the human microbiome are strongly linked to a wide range of oral cancers. Among the oral cancers, oral squamous cell carcinoma is the most extensively researched oral cancer[31]. Oral squamous cell carcinoma (OSCC) is a type of head and neck cancer that has become increasingly prevalent worldwide, especially among younger age groups[32,33]. OSCC is a fast-growing carcinoma that can quickly metastasize to nearby lymph nodes in the neck. The most common clinical presentation of OSCC is non-healing ulcers, which may be symptomatic. There are several established risk factors for OSCC, with alcohol and tobacco use being the most significant. These two risk factors account for 74% of the population-attributable risk for OSCC. Other risk factors include poor oral hygiene, chronic oral infections, human papillo MA virus (HPV) infection, and exposure to certain Occupational hazards such as asbestos and wood dust [34,35,36,37].

A recent study examining saliva samples from oral squamous cell carcinoma (OSCC) patients and healthy volunteers found that three bacterial species - Prevotellatannerae, Fuso bacterium nucleatum, and Prevotella inter media - were associated with an increased risk of OSCC. These findings suggest that the oral micro bio me may play a role in the development of OSCC.[38]In addition to this study, other research has also linked periodontitis-correlated bacterial taxa with an increased risk of OSCC. For example, Porphyromonas gingival is, Pseudomonas aeruginosa, Fusobacterium Periodontium, Aggregatibacter sengis, and Cam pylobacter rectus were found to be significantly increased in the microbiota of OSCC. These bacteria are often associated with chronic in flammation and may promote the growth and spread of cancer cells [39,40,41]. On the other hand, some bacterial species like Streptococcus, Veillonella, and Rothia were found to be considerably reduced in cancer tissue. These bacteria are typically found in healthy oral micro bio ta and have been associated with maintaining oral health[42].

Conclusion

The mouth is a complex ecosystem that contains a diverse population of microorganisms that play a crucial role in our overall health. While many oral bacteria are beneficial and help maintain a healthy mouth, others can contribute to the development of oral diseases. Advances in technology have allowed researchers to study the oral microbiome in greater detail, providing insights into the composition and function of these communities. Good oral hygiene practices, such as brushing and flossing regularly, can help promote a healthy oral microbiome and reduce the risk of oral diseases. Researchers are exploring new therapies and treatments that target specific oral bacteria or modulate the oral micro bio me, which may lead to novel and effective strategies for preventing and treating oral diseases. Understanding the complex communities of microorganisms in our mouths and their interactions can help improve the quality of life for millions of people around the world.

References

1. Pedersen AML, Belstrom D. The role of natural defences in maintaining a healthy oral micro bio ta. J Dent 2019;8: S3-S12.

2. Baquero F, Nombela C. The microbiome as a human organ. Clin Microbiol Infect 2012; 18:2-4.

3. Lamont RJ, Koo H, Hajishengallis G. The oral micro bio ta dynamic communities and host interactions. Nat Rev Microbiol 2018; 16:745-759.

4. Willis JR, Gabaldon T. The Human Oral micro bio me in Health and Disease: From sequences to ecosystem 2020; 8:2-28.

5. Pignatelli P, Romei FM, Bondi D, Giuliani M et al. Microbiota and oral cancer as a complex and dynamic micro environment: A Narrative review from etiology to pro gnosis. Int J Mol Sci2022; 23:2-17.

6. Lederberg J, McCray AT. Ome sweet omics- a genea logical treasury of words. Scientist 15:8-10.

7. Theilade E. Factors controlling the microflora of the healthy mouth. In M J. Hill and P.D. Marsh (ed.), Human micro bial ecology. CRC Press, Inc., Boca Raton Fla.

8. M. Kilian. The oral microbiome- friend or foe? Eur. J. Oral Sci 2018; 126:5-12

9. Hug LA et al. A new view of the tree of life. Nat Microbiol 2016; 1:16048.

10. Takeshita T, Naakano Y, Kumagai T et al. The eco logical proportion of indigenous bacterial populations in saliva is correlated with oral health status. ISME 2009; 3:65-78.

11. J.L. Baker, B. Bor, M. Agnello, W. Shi et al. Eco logy of the oral micro bio me: beyond bacteria, Trends Microbiol 2017; 25 (5): 362–374.

12. A.C. Tanner, C.A. Kressirer, L.L. Faller. Under standing caries from the oral micro bio me perspective. J. Calif. Dent. Assoc 2016;44 (7): 437–446.

13. Feki A, Molet B, Haag R, Krem ar M. Protozoa of the human oral cavity (epidemiological correlations and pathogenic possibilities). J Biol Buccal 1981;9(2):155-61.

14. Sharma N, Bhatia S, Sodhi AS, Batra N. Oral micro bio me and health. AIMS Microbiol 2018; 4:42-66.

15. Wang W, Jovel J, Hallora B, Win E, Patterson J, Ford G, Madsen K. L. Metagenomic analysis of viral com munities in the human oral cavity. Journal of dental research 2015;94(11):1571-1581.

16. Kilian M, Chapple IL, Hannig M, Marsh PD, Me uric V, Pedersen A Metal. The oral micro bio me – An update for oral healthcare professionals. Br Dent 2016; 221 (10):657 -66.

17. Marsh PD. Microbial Ecology of Dental Plaque and its Significance in Health and Disease. Adv Dent Res. 1994; 8 (2):263-271.

18. Dewhirst FE, Chen T, Izard J, et al. The human oral micro bio me. J Bacteriol. 2010;192(19):5002-5017.

19. Wu GD, Chen J, Hoffmann C, et al. Linking long-term dietary patterns with gut microbial entero types. Science. 2011; 334 (6052):105-108.

20. Hajishengallis G, Darveau RP, Curtis MA. The Key Stone -Pathogen Hypothesis. Nat Rev Microbiol. 2012; 10 (10):717-725.

21. Schwartz, J, Koenig K. L. Human oral micro bio ta and its modulation for oral health. Environ Health Per spect 2017; 125(2): 250-256.

22. Huang, C. B., Alimova, Y., Myers, T. M., & Eber sole, J. L. Short-and medium-chain fatty acids exhibit anti micro bial activity for oral micro-organisms. Archives of oral biology 2012; 57(6): 650-654.

23. Zaura, E., Nicu, E. A., Krom, B. P., Keijser, B. J., & Acosta-Gutiérrez, S. Oral microbial ecology and the role of salivary immuno globulin A. Microbiology and Molecular Biology Reviews 2017, 81(4), e00001-17.

24. Marsh PD. Role of the oral microflora in health. Microbial Ecol Health Dis 2009;12:
130-7.

25. Willis JR, Gabaldon. The Human Oral Microbiome in Health and disease: From sequences to Ecosystems 2020; 8:1-28.

26. Wade WG. The oral micro bio me in health and disease. Pharmacol Res2013; 69:137-43.

27. Zickert, I, Emil son, C.G. Correlation of level and duration of Strep to coccus mutans infection with inci dence of dental caries. Infect. Immune 1983; 39:982–985.

28. Aas J. A, Griffen AL, Dardis SR, Lee AM, Olsen I, Dewhirst FE. Bacteria of dental caries in primary and permanent teeth in children and young adults. J. Clin. Micro biol.2008; 46: 1407–1417.

29. Lenartova et al. The Oral Micro bio me in Perio dontal Health. Front cell Infect Microbiol2021; 11:1-6.

30. Dewhirst F E, Chen T, Izard J, Paster B J et al. The human oral micro bio me. J. Bacteriol. 2010; 192:5002–50 17.

31. Filoche S, Wong L, Sissons CH. Oral bio films: emerging concepts in micro bial ecology. J Dent Res 2010; 89:8-18.

32. Socransky S, Haajee A, Cugini M, Smith C, Kent RL. Micro bial complexes in subgingival plaque. J Clin Perio dontol 1998; 25:134-144.

33. Kirst ME, Li EC, Alf ant B, Chi YY, Walker C, Magnusson I. Dysbiosis and alterations in predicted functions of the sub gingival microbiome in chronic Perio dontitis. Appl Environ Microbiol. 2015; 81:783-793.

34. Hayes RB, Ahn J, Fan X et al. Association of oral micro bio me with risk for incident head and neck squamous cell cancer. JAMA Oncol. 2018;4(3):358-365.

35. Ng JH, Iyer NG, Tan MH, Edgren G. Changing epidemiology of oral squamous cell carcinoma of the tongue: A global study. Head Neck 2017; 39:297-304.

36. Du M, Nair R, Jamieson L, Liu Z, Bi P. Incidence trends of lip, oral cavity and pharyngeal cancers: global burden of disease. J Dent Res 2020; 99:143-151.

37. Rogers SN, Ved Pathak SV, Lowe D. Reasons for delayed presentation in oral and oropharyngeal cancer: the patient's perspective. Oral Maxillofac Surg 2011; 49 (5): 349-53.

38. Abu-Ghanem S, Yehuda M, Carmel N, Leshno M, Aber gel A, Gut Feld O, et al. Elective neck dissection vs observation in early-stage squamous cell carcinoma of the oral tongue with no clinically apparent lymph node meta stasis in the neck a systematic review and meta-Analysis. Head Neck Surg. 2016 Sep; 142(9): 857–65.

39. Ding Z, Xiao T, Huang J, Yuan Y, Ye Q, Xua M, et al. Elective neck dissection versus observation in squamous cell carcinoma of oral cavity with clinically N0 neck: A systematic review and meta-analysis of pro spective studies. J Oral Maxillofac Surg. 2019 Jan; 77 (1):184–94.

40. Zhao H, Chu M, Huang Z, Yang X, Ran S, Hu B, Zhang C, Lian J. Variations in Oral Micro bio ta Associ ated with Oral Cancer. Sci. Rep. 2017; 7: 1-10.

41. Hebshi AL, Nasher NN, Maryoud MY, Homeida HE, Chen T et al. Inflammatory Bacteriome featuring Fuso bacterium Nucleatum and Pseudomonas Aerugi nosa identified in association with oral squamous cell carcinoma. Sci Rep 2017;12(7):1-10.

42. Crusz, S.M, Balkwill F.R. In flammation and Can cer: Advances and New Agents. Nat. Rev. Clin. Oncol. 2015; 12:584–596.