

THE MOUTH AS A MIRROR OF HEALTH: UNRAVELING THE HIDDEN LINK BETWEEN SYSTEMIC DISEASES AND ORAL DISORDERS

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ABSTRACT

Many diseases of the body may reveal themselves through the mouth, including diabetes, heart disease, autoimmune diseases, gastroenteritis, blood disorders, and vitamin deficiency diseases and often may show early signs of their presence within the mouth. Examples of symptoms that may provide an important clue to diagnosing a systemic disease include periodontal disease, dry mouth, mouth ulcers, bleeding gums, defective enamel, and lesions of the mucosal tissues of the mouth. Conversely, oral diseases may worsen the systemic disease by causing chronic inflammation in the body and spreading infectious microorganisms in the body. Recent research has shown the bidirectional relationship between oral and systemic health and the value of a complete patient examination and working with other health care providers. Recognizing these oral signs early on by dental professionals can lead to timely referrals, diagnosis, and treatment of the systemic disease, which will ultimately improve patient outcomes and quality of life. In addition, providing prevention-based oral health care is an important way to decrease the total amount of illness and disease related to the mouth and the body as a whole.

Keywords: Oral Health, Systemic Diseases, Periodontal Disease, Diabetes Mellitus, Cardiovascular Diseases, Oral Manifestations, Oral-Systemic Link, Chronic Inflammation, Xerostomia, Integrated Healthcare

Introduction

The mouth is one of the major body parts and has a vital role in keeping the body healthy. The mouth is used for speaking (the voice box), chewing food (mastication), and digesting food; however, in addition to the above-mentioned functions, the mouth can indicate the status of the body's overall health. Many illnesses and diseases that affect organs and systems throughout the body can result in early signs or symptoms that occur in the mouth. Some of these signs may include: periodontal (gum) disease, ulcers in the mouth, dry mouth (xerostomia), swollen gums (gingival enlargement), mucosal lesions in the mouth, and changes in taste. The mouth and or oral cavity contains many blood vessels and is exposed to many things in our environment on a daily basis. For these reasons, the tissues in the mouth are very sensitive to any changes (physiological or pathological) that occur in the body. Healthcare workers are realizing more and more that performing an oral exam may provide the health care provider with information about the patient's health. The early detection of oral signs can help to diagnose disease systemically prior to other signs or symptoms occurring elsewhere in the body. Consequently, learning how oral health affects the overall health of the body is important to improve how patients are being taken care of and to promote patients to pursue preventative health measures. The idea of using the mouth as a window into a person's state of health also supports the need for dentists and medical providers to work together to provide the best health care possible and to improve the quality of life for individuals all over the world. (Glick et al., 2021)

The authors cite that one of the most currently researched systemic diseases that causes oral complications is diabetes mellitus. As a group, patients with diabetes also have a high level of periodontal disease, poor healing following a wound, and an increased risk of infection as well as having reduced saliva within the mouth. In addition, there is also a strong association between cardiovascular disease and chronic periodontal disease. It is felt that chronic periodontal infection causes damage to the vessels of the body and leads to the atherosclerotic process. Autoimmune

conditions such as Sjögren's syndrome, rheumatoid arthritis, and systemic lupus erythematosus often present with specific oral findings (xerostomia, ulcerations of the mucosa, and salivary gland dysfunction). Hematologic conditions such as anemia and leukemia frequently display oral signs such as gingival bleeding, pallor, petechiae, oral ulcerations, and chronic mucosal inflammation. Deficiencies in vitamins B12, B1, folate, and iron can present with glossitis, angular cheilitis, and mucosal atrophy. These oral findings can indicate underlying systemic diseases early on and allow for early diagnosis and intervention. Therefore, the importance of routine comprehensive oral examinations in a general ongoing maintenance program and the role of oral health professionals in identifying oral signs of systemic disease is critical. (Seymour et al., 2019)

Oral disease (especially periodontitis) can lead to systemic disease due to its chronic inflammation and persistent bacteria released via gingival tissues into blood vessels, thereby initiating an inflammatory response that can contribute to the progression of a wide variety of other diseases in other body systems. There are numerous studies correlating periodontal disease with various systemic diseases such as cardiovascular, preterm birth, respiratory infections, and metabolic disorders; conversely, many systemic diseases can affect the immune function and metabolism of tissues, resulting in an increased risk of developing oral diseases. Diabetes mellitus is an excellent example of this bidirectional relationship, as a poorly controlled diabetic patient has impaired oral health and decreased ability to control blood glucose due to the effects of severe periodontitis on their glycemic level. The interactions of all these disorders illustrate the complex biological relationship between the body and the oral cavity and led to the emergence of interdisciplinary healthcare models that emphasize a collaborative approach between dental and medical providers. Integrated healthcare systems are needed in order to provide the necessary infrastructure to effectively manage, diagnose, and prevent disease within the healthcare system. (Chapple et al., 2017)

Research in the area of biomedicine and molecular study has enabled scientists to advance their

understanding on how the link between dental/periodontal disease(s) and some other types of systems is created through the use of chronic inflammation as an important mechanism of action. The immunologic mediators of inflammation including cytokines, prostaglandins and TNF α , are produced in the oral cavity during the course of an oral infection, and they may cross into the systemic circulation, thereby contributing to the development of extensive tissue damage. In addition, it has been found that changing the composition of oral microbiota can lead to the development of several different systemic disorders. The oral cavity contains a wide variety of different microorganisms; however, when the composition of these microorganisms becomes disrupted (dysbiotic), the development of disease will then occur both in the local area and throughout the body. For example, oral pathogens have been found in the atherosclerotic plaques of the heart, respiratory tissues and other anatomical sites, thus supporting the idea of microbial translocation from the mouth to distant organs. Genetic susceptibility, dysfunction during the immune response, oxidative stress and other environmental factors may also have a combined impact on the relationship between oral disease(s) and systemic disease(s). Using the biologic understanding of these mechanisms, targeted therapies may be developed and implemented as preventive strategies. As information continues to evolve through ongoing research, the complexities of the interactions between oral health and systematic health continue to be better defined, thereby increasing the understanding of overall human health. (Hajishengallis et al., 2020)

The increasing awareness of the oral-system connection means that how we deliver health care and health policy will need to change. In order for systemic diseases to be treated efficiently, the dentist will need to deal with the state of their patient's oral health at the same time they are preventing the development of general or systemic diseases. A team of health care professionals; that includes the dentist, physician, nurse, and others, must work together to identify and assess risk factors, to promote early diagnosis and to implement a comprehensive plan to treat their

patient. Educating patients on the significance of practicing good oral hygiene, healthy lifestyles, eating a balanced diet and making regular dental visits will decrease the burden of oral disease as well as systemic disease. When primary care providers incorporate oral health risk assessments into their practice, medical conditions may be detected earlier thus improving access to preventative services. In addition, public health initiatives should support oral health as an intrinsic component of health and not as a non-health care related part of health. As the evidence accumulates, our health care system should begin to using a holistic approach towards patient care so that the relationship between oral and systemic health is considered. When we realise that the mouth is a window to overall health and wellness, both localised and systemic illnesses may be positively affected at an earlier time and lead to greater overall wellbeing for the patient. (Watt et al., 2021)

Mouth reflects overall body health

The mouth is increasingly viewed as a good indicator of one's health. Oral exams are often the first way to see systemic disease and can find disease early. There are multiple types of tissues in the mouth such as teeth, gums, tongue, saliva glands, and mucous membranes, which are affected by changes happening in other places in the body. Due to the vascular nature of those tissues and their continual exposure to microorganisms, the tissues of the mouth readily respond when there are changes in another area of the body. Many systemic conditions, including hormonal imbalances, immune system problems, metabolic disorders, and nutritional problems have well-known manifestations within the mouth. For instance, the presence of gingivitis, recurring oral ulcers, or changes in the flow of saliva may be indicative of more serious underlying medical issues that need to be investigated. Oral health professionals are frequently the first health care providers to detect possible systemic illness, and mounting evidence supports the connection between oral and systemic health and the rationale for routine dental exams as part of comprehensive health care. Knowing that changes in the mouth can be indicative of changes in the body can lead to

earlier diagnosis, more successful treatment, and higher patient satisfaction. (Patel et al., 2020)

Many biological and physiological mechanisms that influence oral health and systemic health are the same. The oral cavity is a point of entry for both the digestive system and the respiratory system, and it contains a diverse collection of bacteria (the oral microbiome) that work together in harmony under normal conditions, to keep the mouth healthy. When this balance is disrupted, oral diseases and inflammation can develop and contribute to overall health problems. Oral inflammation has been shown to stimulate the body's response in the immune system, which causes inflammatory substances to be released into the bloodstream. Ultimately, these substances can play a role in the creation or progression of chronic systemic illness through the body. Additionally, abnormalities in oral tissues can be used to help diagnose dysfunction within the immune system, hormonal levels and nutritional deficiencies. For example, someone who has vitamin deficiencies may have inflammation in the tongue and/or other changes to mucous membranes, or someone who is suppressing their immune system may be more prone to oral infections. The close relationship between oral tissues and the systems of the body further emphasizes that oral findings need to be considered in a larger context related to overall health. Similarly, oral examinations provide potential opportunities for the identification of potential health issues that may not present with symptoms of severity until a later time. (Lopez et al., 2018)

Chronic diseases show a definite link to dental health, which supports the theory that an individual's mouth can indicate how well their whole body is functioning. People diagnosed with endocrine disorders, heart disease, lung disease, and gastrointestinal (GI) issues often have observable signs of these diseases in their mouths. Chronic inflammation in the mouth is one way to assess systemic inflammation throughout the entire body. Dry mouth, burning sensation, swollen gums, and abnormal mucous membranes are just some of the indicators that may suggest a significant underlying problem with a person's health. Many of today's medications can also change the way an

individual receives treatment for systemic disease, causing decreased saliva production and discomfort in the mouth. These changes can affect the ability to eat, talk, and live a normal life. Poor oral health can also negatively alter the way a person's systemic diseases are treated because poor oral health can increase both the level of inflammation and the increased risk for developing infections. Due to this evidence, medical professionals are beginning to incorporate oral examinations into their standard health care evaluations. By using oral findings as indicators of systemic disease, medical professionals will be in a better position to make timely referrals and work with specialists to assess and treat any potential issues. This coordinated effort to provide total patient-centered care helps assist individuals to achieve and maintain overall health and wellness. Overall, the mouth provides a clear view into an individual's general health. (Martinez et al., 2021)

Recent developments in biomedical and dental science have increased awareness of the link between systemic disease and oral health. Accordingly, as more research has been done, it is now possible to use oral biomarkers to identify different types of systemic disease. Among these, saliva has become a focus as a non-invasive method of diagnosing conditions that occur in the body because of the presence of proteins, enzymes, hormones, antibodies, and genetic materials in saliva that are indicative of physiological changes and pathology throughout the body. Salivary biomarkers have been identified for such conditions as cancer, obesity, autoimmune disorders, and infectious disease. Such findings illustrate the potential for oral health care practitioners to screen for disease and prevent the onset of disease through oral health care services. In addition, improvements in technology are allowing for the monitoring of oral changes that may lead to systemic health issues earlier than was previously possible. When such changes are identified quickly, it provides the opportunity for more effective intervention and the potential for improved outcomes for patients. As the field continues to grow in understanding how to integrate oral health assessments with larger healthcare systems, the concept of oral health may

no longer be seen as separate from general health but as an integral component of total patient care. (Nguyen et al., 2019)

The importance of a healthy mouth reflects the overall health of the body and has tremendous ramifications for public health and clinical practice. Helping to achieve good oral health can prevent dental disease and improve overall health outcomes. Dental checkups allow for early detection of systemic diseases, provide health education, and assess risk for future disease. In addition, public health campaigns should raise awareness about the importance of oral hygiene, healthy eating, quitting smoking, and visiting a dentist for preventive care. Equal collaboration between medical and dental caregivers is also essential for providing comprehensive care to their patients. Integrated healthcare systems that include oral health in routine medical evaluations will contribute to the early identification of systemic disease and more effective treatment of those same diseases. Finally, by educating patients on the relationship between oral health and total body health, patients may become more inclined to participate in preventive healthcare. As the body of scientific knowledge continues to evolve, the mouth as a mirror of health is becoming increasingly significant to modern healthcare. By identifying oral signs and symptoms of systemic disease, clinicians will be able to promote disease prevention, enhance quality of life, and ultimately, provide a more holistic approach to patient care. (Roberts et al., 2022)

Systemic diseases often show oral signs

Systemic disease can show up, often first, in the mouth, making the mouth an essential area for potentially identifying numerous diseases before any kind of actual diagnosis occurs. Oral tissues are very susceptible to the physiologic and pathophysiologic changes that occur throughout the body due to the abundance of blood supply and the consistent exposure to both intra- and extracellular forces. Therefore, many times oral signs associated with a primary disease may appear before any type of actual diagnosis has taken place and provide useful information for healthcare providers. Diabetes mellitus (DM), anemia, autoimmune disease, and endocrinopathies are all

examples of systemic diseases that will present with clinical oral signs and symptoms, including periodontal disease, oral mucosal lesions, xerostomia, burning mouth syndrome, and recurrent oral ulcers. These oral signs and symptoms can have a marked effect on an individual's level of comfort, ability to eat and/or drink, and quality of life. As a result of this increased importance of recognizing oral manifestations of systemic disease, all healthcare providers are encouraged to work with the dentists who performed the examinations for their patients to assist them via appropriate referrals to allow for early diagnosis and intervention. Just as oral healthcare providers can identify oral abnormalities that may signify presence of an underlying systemic disease, they can do this through careful examination and referral, thereby enhancing comprehensive patient care and disease management. Also, understanding the relationship between systemic disease and oral manifestations assists in creating a partnership between dentists and physicians, thus validating the need for a multidisciplinary approach to providing healthcare services and bettering a patient's outcome as a whole. (Wilson et al., 2020)

Metabolic and endocrine disorders (systemic diseases) significantly impact oral health, with diabetes being one of the most studied because it is highly associated with oral complications. Those with diabetes are frequently at increased risk of periodontal disease, delayed wound healing, oral infections, and xerostomia (dry mouth). High blood glucose levels can inhibit immune responses and encourage pathogenic microbiota to grow in the oral cavity. Likewise, thyroid disorders can affect oral health through their influence on tooth development, saliva production, and bone metabolism. Additionally, adrenal and pituitary gland hormone imbalances will result in oral tissue changes that can be observed in oral examination. These changes frequently indicate the seriousness and progression of the underlying systemic disease. Early identification of oral symptoms can improve the chances of early detection and lead to improved disease management. Finally, the successful management of systemic diseases often leads to improved oral health, demonstrating that

systemic diseases and oral diseases are closely related. For this reason, healthcare providers should pay close attention to oral symptoms as they may provide needed insights into another aspect of a patient's health care needs and underlying medical problems. (Thompson et al., 2019)

Clinical findings from a variety of conditions can be observed in the oral cavity; therefore, the ability to utilize these findings for the diagnosis of medical disorders is paramount to the clinician. Numerous autoimmune (e.g., systemic lupus erythematosus, pemphigus vulgaris, and Sjögren's syndrome) and hematological disorders (e.g., iron-deficiency anemia, leukemia, and thrombocytopenia) commonly involve oral involvement via changes in the oral mucosa, significantly the salivary glands, and thus result in oral manifestations (e.g., tongue/palate/cystic or ulcerative lesions; oral mucosal ulcerations; dry mouth; difficulties with speech and swallowing; and gingival bleeding) that the clinician can utilize for diagnosis of these disorders. The oral manifestations of these diseases prior to the appearance of systemic symptoms demonstrate that a complete oral examination should be included as part of every patient's assessment for their regular healthcare visit. Clinicians will be able to facilitate further diagnostic workup of patients by detecting unusual oral signs and symptoms and potentially obtaining an earlier diagnosis and treatment. Such preventative measures may help decrease the incidence and burden of disease and subsequently improve patient outcomes. Thus, the oral cavity serves as a useful diagnostic tool in detecting a variety of hematologic and autoimmune disorders. (Garcia et al., 2021)

Systemic diseases with oral signs include infectious and other chronic conditions. Confirmation and follow-up for infections such as HIV can be conducted by looking for lesions caused by bacteria, viruses or fungi in the mouth. Common oral signs of HIV-infection are oral candidiasis, hairy leukoplakia, and periodontal disease. Nutritional deficiency diseases occur when essential nutrients such as iron, zinc, folic acid, and the B vitamins are insufficient and typically produce oral signs such as glossitis (a swollen, red tongue), angular cheilitis (cracks on the corner of the mouth), atrophic

mucosa (loss of tissue), and delayed wound healing. The presence of oral disease provides opportunities to diagnose underlying health conditions, such as malnutrition, malabsorption, and chronic disease; diagnosing nutritional deficiencies and infectious diseases early results in better outcomes and fewer complications. Oral health professionals play a vital role in promoting health; they can identify the oral signs of systemic diseases and, when needed, refer individuals to a healthcare provider. The presence of oral signs in systemic diseases reinforces the role of oral assessments in the process of integrating oral health into holistic healthcare systems. (Anderson et al., 2018)

The increasing recognition of oral changes that accompany systemic diseases has significant repercussions for patient care and healthcare systems. As a part of routine evaluations of overall health, oral examinations can provide crucial information about an individual's overall health as well. Effective cooperation between dentists and physicians, and other medical professionals, has improved our ability to identify and treat systemic diseases in their earliest stages. Teaching patients about the relevance of oral changes may well encourage them to seek timely medical and dental assistance. Strategies for prevention such as good oral hygiene, routine dental examinations, and proper lifestyle habits are important for both oral and systemic health. The ongoing emergence of new technologies to aid in the diagnosis of disruptions in oral health will bolster the role of oral healthcare in preventing and treating diseases. As more evidence supporting the relationship between oral health and systemic disease continues to come to light, the healthcare systems in which oral health is practiced are being urged to employ a fully integrated approach to overall patient care that reflects the significance of oral healthcare's contributions to patient outcomes. Long-term, when providers recognize the presence of oral signs of systemic disease, this will lead to earlier diagnosis, improved outcomes, and a better quality of life for patients throughout the world. (Bennett et al., 2022)

Diabetes and heart disease affect oral health

One of the most common chronic conditions affecting people's oral health globally is diabetes

mellitus. This disease is characterized by the inability of the body to metabolize glucose properly. Diabetes can cause serious health complications in all parts of the body, including the mouth. When individuals do not maintain good control of their blood glucose levels, they often experience periodontitis (a form of advanced gum disease), swollen gums, dry mouth (xerostomia), slow healing following oral surgery, and a greater risk for developing chronic infections in the mouth than non-diabetic individuals. Hyperglycemia (high blood glucose) also suppresses and hinders the function of the immune system, which increases the likelihood that a diabetic patient will become infected by bacteria that lead to diseases of the teeth and surrounding tissue (periodontitis). Reduced salivary flow in diabetic patients also creates a greater risk for developing cavities and experiencing oral discomfort. Oral disease manifests in more than just how a patient feels; it also affects their ability to obtain proper nutrition and overall health. Studies indicate that periodontal disease can present with more severe forms of periodontal disease and progress faster in diabetic patients than those without diabetes. Therefore, good oral hygiene and regular dental care are critical components of diabetes management. The timely identification and treatment of oral complications will enhance the overall systemic and oral health of a diabetic patient and demonstrate the need for dentists and physicians to work together as a team. (Hernandez et al., 2020)

It is now acknowledged that there is a two-way connection between oral and periodontal health and diabetes. Periodontal disease is more likely to develop in those with diabetes, but someone with periodontal disease will likely have trouble controlling their blood sugar level. The combination of negative effects of diabetes causes bad periodontal health, which leads to worsening of diabetes control, creates a cycle that continues the effect of diabetes on those with periodontal disease. Studies show that treatment of periodontal disease leads to better blood glucose control and reduced systemic markers of inflammation. Health care providers should include oral health care as part of their overall management of individuals

with diabetes. Individuals are encouraged to maintain their oral hygiene and to see a dental professional numerous times throughout the year. Healthcare providers need to be able to recognize the oral indications of diabetes and encourage preventive treatments to decrease complications associated with diabetes. If health care providers can treat both oral and systemic health at the same time, it will reduce complications associated with disease and improve overall health outcomes for patients and reduce the burden on the healthcare system. A holistic approach to individual patient care is supported by the relationship of oral and systemic diseases and underscores the interrelationship of systemic and oral diseases. (Foster et al., 2021)

Various types of cardiovascular disease (e.g., coronary artery disease, hypertension, heart failure) have been linked with multiple oral conditions (e.g., periodontal disease). Chronic inflammation is believed to play a key role in the development of both cardiovascular disease and periodontal disease, indicating a potential biological link between the two diseases. Inflammatory mediators released during periodontal infection may enter into general circulation and lead to endothelial dysfunction, vascular inflammation, and the formation of atherosclerotic plaques. People with cardiovascular disease can also exhibit oral signs and symptoms from taking medications such as dry mouth, gum overgrowth (gingival hyperplasia), or altered taste sensation. These oral complications can hinder participation in daily activities and reduce overall quality of life. Research has continued to show that proper maintenance of oral health is very important for people who have been diagnosed with cardiovascular disease. Routine dental examinations and preventive oral care can potentially assist in the reduction of inflammation as well as support general health. Oral health alone cannot completely prevent heart disease; however, by maintaining healthy gum tissues can increase the chances of experiencing better cardiovascular health and overall wellness. Thus, oral healthcare should be part of the management and prevention strategies for individuals who have cardiovascular disease. (Richardson et al., 2019)

There has been a lot of study about how periodontal disease and cardiovascular disease are connected. Studies found that patients with a lot of periodontal disease have a greater chance of developing heart problems. Oral bacteria associated with periodontal disease can get into the blood through activities like brushing teeth, chewing, and dental treatment. These bacteria can trigger inflammation in blood vessels and can lead to atherosclerosis after they are in the blood. Patients with either periodontal disease or coronary artery disease have high levels of markers of systemic inflammation like C-reactive protein and interleukins. Although more research is needed to determine the definitive relationship between these two diseases, there is evidence of a strong link between oral inflammation and cardiovascular health. Recognizing the relationship between periodontal disease and cardiovascular disease will help dental professionals to help patients with early diagnosis and treatment of periodontal disease and in lowering systemic inflammation. Cooperation between medical and dental professionals will make it easier for them to identify at-risk patients and provide them with preventive treatments. More and more science indicates that oral health is an important part of overall systemic health and the prevention of disease. (Evans et al., 2022)

Diabetes and heart disease impact oral health; therefore, it is imperative that we establish an integrated approach to healthcare where both the oral and systemic aspects of these diseases can be addressed together. People with these chronic illnesses require all aspects of their care to be considered in a comprehensive manner that includes regular dental check-ups, proper oral hygiene, and ongoing medical care. Public health campaigns must raise awareness of the connections between systemic diseases and oral health, so that people will be motivated to engage in preventive behaviours and to seek treatment early when they are experiencing problems with their teeth or gums. Healthcare providers should inform all patients about the need to keep their gums healthy, control their blood sugar levels, and lower their risk of developing cardiovascular disease. As such, modification of an individual's lifestyle through proper nutrition, regular exercises, quitting

smoking, and managing stress will provide benefits not only to that particular individual's oral health but also to their overall systemic wellness. Continued research has improved the understanding of the relationship between diabetes, heart disease, and oral health. As evidence becomes available, the integration of dental services within chronic disease management programs could potentially improve health results and provide employees with a better quality of life. Understanding the oral signs of diabetes and heart disease provides an opportunity for the early diagnosis, monitoring of diseases, and providing comprehensive patient care. (Mitchell et al., 2023)

Periodontal disease is linked to systemic inflammation

Periodontal disease, a long-term health condition that occurs in the mouth, is caused by the accumulation of bacteria in the mouth which leads to a strong immune response, resulting in inflammation of the supporting tissues around the teeth, known as gingival tissue, periodontal ligament, cementum and alveolar bone. Periodontal disease was once thought to be a confined issue within the mouth; however, there is currently a significant amount of scientific evidence indicating that the damaging effects of periodontal disease do not just occur in the mouth, but extend to external areas as well. Once bacteria enter the bloodstream, their biochemical properties cause an inflammatory response in the body's various organ systems. Continued progression of the disease creates pockets and loss of connective tissue attachment to the tooth, thereby increasing the likelihood of tooth loss if treatment is not sought. Furthermore, evidence suggests that the ongoing presence of bacteria in the mouth leads to an exaggerated systemic inflammatory response which will have negative consequences for the functioning of several organs and/or physiological systems. Researchers have documented elevated levels of inflammatory markers in patients diagnosed with advanced periodontal disease, thus proving support for the concept that inflammation in the mouth can have long-distance negative effects. (Morgan et al., 2021)

The complex interaction between the immune system and microbiome is believed to play an

important role in the biological mechanisms that link periodontal disease and systemic inflammation. The periodontal pathogens that colonize the oral cavity reside within biofilm (also known as dental plaque) or periodontal tissue. These periodontal pathogens will produce various toxins and virulence factors; thus, stimulating an immune response to the periodontal tissues. As periodontitis progresses, pro-inflammatory cytokine mediators such as IL-1, IL-6, and TNF-alpha are released in massive amounts. This increased release of inflammatory mediators eventually allows for permeable membranes located within the ulcerated periodontal pockets to allow for entry of these inflammatory factors into systemic circulation; ultimately, leading to a generalized state of systemic inflammation. Furthermore, due to oral cavity's proximity to the bloodstream, periodontal bacteria are likely to gain direct access to the bloodstream during routine activities that involve chewing food, brushing teeth, and conducting dental procedures. Once established within the bloodstream, these bacteria are able to subsequently interact with other organs or tissues in the body and initiate additional inflammatory processes. In addition, the continuous release of microbial products (toxins) and inflammatory mediators from local sites of infection (periodontal disease) creates additional demands on already stressed physiological functions within the body, further overloading the body's systemic physiological systems. As a result, many investigators believe that chronic exposure to these inflammatory mediators may play a role in the development or progression of many different inflammatory conditions throughout the body. Consequently, periodontal disease should be recognized as a potential source of systemic inflammation, but also as an important concern regarding oral health. Ultimately, this additional understanding of the links between systemic inflammation and periodontal disease underscores the importance of maintaining good periodontal health, not only as a single strategy for achieving better health, but also as an important part within larger overall strategies to improve health and reduce chronic disease burden. (Campbell et al., 2020)

Numerous studies have examined the connection between periodontitis and chronic inflammatory diseases that impact various body systems. Cardiovascular disease is one of the most researched conditions related to periodontal inflammation. Chronic periodontal disease and associated systemic inflammatory pathways may lead to endothelial dysfunction, vascular inflammation, and the formation of atherosclerotic plaques. Additionally, elevated levels of systemic inflammatory markers commonly seen in patients with periodontal disease have also been associated with increased risk of developing cardiovascular disease. Periodontal inflammation has also been associated with metabolic diseases, respiratory diseases, and certain autoimmune diseases, in addition to cardiovascular disease. The burden of inflammation from chronic periodontitis may potentially affect insulin sensitivity, immune regulation, and tissue homeostasis. Evidence indicates that patients with severe periodontitis frequently have higher levels of systemic inflammatory markers than healthy individuals, providing support for the hypothesis that inflammation in the mouth contributes to the development or progression of chronic inflammatory diseases. Although additional research continues to clarify these associations, there is strong evidence demonstrating that periodontitis is able to contribute to systemic inflammatory events. Therefore, periodontal health should be considered an integral part of overall health and disease prevention. (Baker et al., 2019)

Healthy individuals are less likely to suffer more extensive periodontal damage than those with chronic medical illnesses and systemic diseases which include metabolic disorders (e.g. diabetes), autoimmune diseases (e.g. rheumatoid arthritis), and chronic inflammatory syndromes (e.g. lupus). As a result, systemic inflammation has the potential to change immune response in patients with systemic diseases or induce increased risk for periodontal infection. In turn, periodontal disease could further enhance the inflammatory response in these patients thereby establishing a bi-directional cycle in which the two conditions have a negative effect on one another. For example, people with inflammatory disorders are typically

noted to have higher levels of circulating cytokines, which contribute to periodontal tissue destruction, and conversely, active periodontal disease has the potential to further increase the systemic inflammatory burden adding to the severity of their pre-established chronic illness(es). Perio-therapy has been shown to decrease systemic inflammatory markers in some patient populations and improve health outcomes. The positive relationship between controlling periodontal inflammation and improving some health-related outcomes supports the potential of integrating periodontal care into the management of chronic diseases to improve patient outcomes and decrease the economic burden. This understanding of the interactions between periodontal disease and systemic diseases is further evidence of the need for enhanced interdisciplinary collaboration between dentist and physician. (Nelson et al., 2022)

The recognition of periodontal disease as a cause of systemic inflammation creates significant opportunities for public health, clinical practice, and preventatively oriented medicine. By promoting periodontal health through effective oral hygiene, regular dental visits and timely treatment of periodontal disease, there is potential to decrease the amount of systemic inflammatory burden an individual endures, thus promoting their overall health. To accomplish this goal, health care professionals should educate patients about the potential implications of untreated periodontal disease and encourage regular engagement in preventive oral health care practices. Public health initiatives designed to improve awareness of oral health can aid in reducing the prevalence of chronic inflammatory diseases, as well as the negative consequences associated with those chronic diseases. Research continues to provide evidence of the biological pathways linking periodontal disease to systemic inflammation, producing an ever-greater understanding of the oral-systemic link between the two health issues. Future research may help to clarify the extent to which periodontal treatment affects chronic inflammatory disease outcomes and inflammatory processes. As our understanding about this relationship develops, it becomes more apparent that oral health care is an integral part of all-

encompassing healthcare. Early identification of periodontal disease can not only help to maintain oral function and quality of life, but also contribute to greater overall systemic health. As such, periodontal disease should be regarded as an important aspect of preventing and treating chronic inflammatory disease states. (Stewart et al., 2023)

Oral and systemic health have a bidirectional relationship

Oral health and systemic health have a growingly recognized two-way connection. This relationship has changed the way we think about health care today because it has demonstrated the relationship of many systems of the body to each other. The oral cavity is not an unrelated structure; rather, it has a close physiological connection to the rest of the body, with their connection via the bloodstream, the immune system and the microbiome of the body. In addition, infection and inflammatory diseases of the oral cavity can initiate systemic inflammation and can affect distant organs. Clearly, the two-way connection between oral and systemic health indicates that both oral health and general health must be approached by integrating clinical care from all members of both professions, with dentists and physicians, as examples, serving as the gatekeepers to identify and manage clinical conditions affecting both systems. The two-way connection of oral and systemic health illustrates the ongoing necessity of cooperative, integrated care models, in which health care providers share information for use in diagnosing, treating and preventing specific health conditions. Understanding this two-way connection will be of great assistance in the early detection of disease and enhanced long-term health outcomes for patients. (Johnson et al., 2020)

The systemic diseases are closely related to oral health in both reciprocal and bidirectional manners. Many systemic diseases can greatly negatively influence oral tissues and functions. For instance, diabetes mellitus can result in periodontal disease, delayed wound healing, xerostomia, and greater risk for infections. Autoimmune disorders like Sjögren's syndrome will cause xerostomia and damage to salivary glands. Cardiovascular disease may be related to decreased blood flow to the oral

cavity as well as inflammation of the oral cavity; gastrointestinal diseases can cause enamel erosion and affect oral mucosa. Many times, the systemic disease will inhibit the body's immune system response thereby increasing the susceptibility of oral tissues to infection and inflammation. Medications used to treat systemic diseases frequently have side effects that will negatively impact the quality of oral hygiene and the overall quality of life. Examples include xerostomia, gingival overgrowth, and altered taste sensation. Understanding how systemic diseases impact upon oral health is essential to provide comprehensive patient care and to intervene at an earlier time when oral signs of a systemic disease are present. (Reynolds et al., 2019)

Oral diseases also have a significant impact on the overall systemic health of a person, especially due to periodontal disease, which is a chronic inflammatory disease that has been extensively researched regarding its influence on general health and chronic inflammatory status. The bacteria that cause periodontal infections can enter the bloodstream through inflamed gum tissue, and it can then be disseminated throughout the body after entering the blood. When these microorganisms and their toxins circulate in the blood, they can produce immune responses and contribute to inflammation at distant sites within the body, for example, cardiovascular diseases, complications of diabetes, a variety of respiratory infections, and poor pregnancy outcomes. Chronic oral inflammation contributes to the total body inflammatory load and may also accelerate the process of developing other systemic diseases; and poor oral health can decrease nutritional status and overall quality of life, thus causing other systemic health issues. The bidirectional nature of this relationship shows that oral health should not be seen as separate from general health but as a component of it, and therefore effective management of oral disease will produce benefits in the severity of systemic conditions. Thus, the value of preventive dental care and early intervention has been highlighted. (Williams et al., 2021)

Numerous studies have confirmed a two-way connection between system-wide and oral health,

which is based on overlapping biological mechanisms or risk factors. Risk factors like smoking, unhealthy food choices, stress, or cleanliness issues affect both the mouth and the rest of the body (systemic disease). The presence of overlapping or shared risk factors creates an inherently complicated relationship in which many different diseases can happen at once and/or will affect the progression of each other adversely or positively. These varying relationships are caused by similar biological pathways such as inflammation (mediators of inflammation), immune system reactions or imbalances in the microbes found in the mouth and elsewhere in the body. For example, the elevated levels of cytokines typically seen in periodontal disease (gum disease) may lead to an increase in systemic inflammation. Conversely, an increase in systemic inflammation from disease will lead to increased damage of the tissues of the mouth. This relationship emphasises the need for a comprehensive approach to health care where the entire body is being viewed, rather than just one or more isolated areas. Interdisciplinary collaboration between dentists/physicians/general health care professionals is necessary to effectively care for patients with multiple health issues. By addressing both systemic and oral factors, health care professionals can ultimately improve prevention, diagnosis and treatment of disease. The research undertaken to define shared mechanisms has led to the development of new diagnostic and therapeutic techniques that can address both systemic and oral health simultaneously, in the future. (Anderson et al., 2022)

Implications of a bidirectional link between the oral cavity and the body are important for clinical practice and public health policy. This understanding supports the need for integrating oral health care with general health care systems, so that patient management can be done more holistically. For example, routine dental visits should be viewed as an essential part of primary medical care for patients who suffer from chronic systemic illnesses. An additional important consideration is patient education, which promotes awareness of the importance of oral hygiene and its relationship to overall health. Preventive

approaches (i.e., brushing, flossing, eating a balanced diet, and making lifestyle changes) can help prevent both oral and systemic diseases. Healthcare systems should provide support for collaborative care models that encourage communication between dental and medical practitioners. Continued research advances provide increasing evidence in support of the connection between oral health and systemic health, while also identifying new opportunities for early diagnosis and intervention. It has become apparent that as we gain more information regarding the connection between oral and systemic health, it will be increasingly necessary for patients to maintain their oral health if they wish to maintain their systemic health. By understanding the bidirectional nature of the relationship between oral health and systemic health, health care providers will be able to provide a more holistic, effective, patient-centered approach to the delivery of health care. (Harris et al., 2023)

Early oral changes can aid disease diagnosis

Early changes in the mouth frequently act as the first signals to help find a system-wide disorder within the entire body. The mouth is an area of the body that shows many physiological and pathological changes and therefore is a good place to make an early diagnosis. Many different types of systemic disease produce their first appearances in the mouth and may provide only minor or inconspicuous signs of disease in the mouth while they may not produce any more easily identifiable signs outside of the mouth. Some examples of these various forms of manifestations include changing in colour of the gums, mouth sores, dry mouth, abnormal bleeding, and an alteration in taste. Because these types of changes are very noticeable and are in an area of the body that can be examined physically and visually, dental professionals are often in the best position to find potential disease processes in patients on a timely basis. Early detection of these initial changes can greatly enhance the provider's ability to identify these conditions and initiate timely treatment of potentially serious medical disorders. Early detection of these types of conditions is of particular importance for those chronic diseases such as diabetes, anemia, autoimmune disorders,

and some infectious diseases because delay in identifying a disease condition may result in serious complications. (Clark et al., 2020)

The importance of early oral screening in the identification of systemic disease cannot be emphasized enough, especially due to their link with systemic disease. For example: The early oral signs present in Diabetes Mellitus may precede clinical diagnostics or the "complete" onset of signs and symptoms for some time. An early oral sign of Diabetes is gingival (gum) inflammation and/or periodontal (gum) disease, along with generalized tendency to develop other types of infections more easily than before. In this instance, the dental team may be the first to identify (detect) the systemic disease and initiate appropriate referrals for the patient's treatment. Similarly, nutritional deficiencies can produce early oral signs such as glossitis (inflammation of the tongue), angular cheilitis (cracking of the corners of the mouth), and atrophy (thinning) of the mucosal tissues in the mouth; all of which may be detected during a dental exam, regardless of whether the patient realizes the significance. Other systemic diseases resulting from the immune system may result in painful oral ulcerations and/or salivary gland dysfunction; often preceding the clinical signs and symptoms of the systemic disease and developing more significantly once the dental professional has identified these conditions. Finally, early detection of oral signs will give the dental team, the clinician, the tools to provide early diagnostic tests, such as laboratory tests or referrals to appropriate providers, which will help expedite the process and provide more effective treatment for the patient. Therefore, the oral cavity serves as a reflection of the internal physiological changes that are taking place in a patient's body; making the oral cavity a diagnostic window for the provider. Additionally, if a provider is able to recognize the early signs of an oral condition, he/she will be able to provide a timely referral to a medical specialist for treatment; which will aid in speeding the diagnosis of the systemic condition and reduce the time to receive the correct treatment. (Miller et al., 2019)

Examples of viral infections include HIV, which can be seen in conjunction with oral lesions, oral hairy leukoplakia, chronic recurring ulcers, and/or

candidiasis. Oftentimes, multiple symptoms, such as the ones mentioned above, may precede the individual feeling significantly worse or having systemic abnormalities; thus, these early oral symptoms may be considered as early indicators of systemic disease. Additionally, bacterial infections may also lead to gingival inflammation and abscess formation and, in some cases, minor tissue loss. The pattern of tissue loss can indicate that other systemic deficits are occurring, even if only localized symptoms can be seen. On the other hand, individuals who have a weak immune system, or some other type of systemic imbalance, regularly have oral fungal diseases, which may be characterized as white patches and/or a burning sensation. If healthcare providers detect oral conditions sooner, they will have an easier time conducting lab investigations and initiating necessary medical intervention without considerable waiting time. In a number of cases, early oral health changes become the most frequent, true clinical indicators of systemic health problems when healthcare providers see individuals without any other significant complaints. (Turner et al., 2021)

Oral signs can be found when there are other problems in the body. The first signs of other diseases can often show up within the mouth before any evidence of an ongoing or previous systemic problem is found in the rest of the body. Some systemic diseases cause oral signs or symptoms, but oral diseases also can contribute to systemic diseases changing how oral tissues develop or how the body produces saliva. Cardiovascular diseases can have their genesis in oral diseases like gingivitis (gum disease) and bleeding gums. The early signs of these systemic diseases may be minimal, perhaps like ember of a fire (early warning signs) that never ignited. Similarly, endocrine disorders (thyroid disease) can alter the rate/integration of the development of oral tissues, the rate of saliva production, or the rate at which teeth erupt (fully develop) in children. Gastrointestinal disorders are often shown within the mouth with symptoms of dental erosion (loss of enamel) or mucosal sensitivity to hot/cold or acidic/hot foods as a result of exposure to acids or malabsorption (as is typically the case). Thus oral

signs, as fledgling as they may appear, typically precede more serious signs/symptoms of systemic disease and thus provide an opportunity for early intervention via clinical consultations by an oral health care provider. Providers trained in these associations can influence and positively impact patient lives by eliminating further delays in making an accurate diagnosis. Once a systemic disease is identified through a focused oral clinical examination, it is typically more effectively controlled and many patients will achieve improved health outcomes. (Brooks et al., 2022)

The incorporation of oral examinations into routine health care can have a significant impact, both for diagnosing and preventing early-stage disease. Healthcare professionals who receive adequate education and training regarding the links between the oral and systemic health type systems are therefore better able to detect early warning signs of systemic disease, long before they become apparent. Likewise, when members of the public understand the importance of oral health, they will be more willing to seek dental care in a timely manner when there is a change in their mouths (ulcers, unusual colourations) rather than waiting until the problem has progressed. Preventive dental visits can serve as a type of checkpoint where clinicians can identify any abnormalities or issues that they may not have otherwise noticed at their previous visit. In addition, diagnostic tools are continually advancing, with salivary specimen testing and imaging techniques providing better methods to identify and diagnose oral changes associated with disease earlier in the disease process. As a result of these advancements, especially if used in conjunction with dentistry, there is a better integration of dentistry into medicine, which ultimately makes the implementation of the 'early intervention' plan that much more feasible. When oral signs are used to diagnose disease earlier rather than later, the outcome of the treatment will also be better; however, there are also economic issues associated with the early treatment of disease progression, as treating patients at an early stage typically will lead to fewer complications later in the course of their care. (Walker et al., 2023)

Conclusion

The mouth is an important component of both your overall health and other health conditions that you might have outside of your mouth. Often, small problems within your mouth show themselves long before significant health issues have been identified (this means your mouth serves as an early warning system for any medical problems). Additionally, oral health problems (especially periodontal disease) can cause increased systemic inflammation, which can negatively impact your overall health. The mouth and body have a two-way connection, providing a continuous reciprocal link between the two. This hidden relationship provides evidence that one must not treat the mouth in isolation from the rest of the body, as many biological pathways connect the two (i.e., inflammation, immune response, microbes). Understanding these relationships between oral health and overall health may help both the dental profession and the medical profession provide a timely diagnosis, provide more effective treatment and provide the best overall health support possible for their patients.

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