

The effects of oral health on systemic health

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The oral cavity is the intersection of medicine and dentistry and the window into the general health of a patient. Hundreds of diseases and medications impact the oral cavity, and pathologic conditions in the mouth have a greater systemic impact than many providers appreciate. It is unclear whether there is true causality or just an association between periodontal disease and certain other systemic conditions, including atherosclerotic vascular disease, pulmonary disease, diabetes, pregnancy-related complications, osteoporosis, and kidney disease. Diabetes has a true bidirectional relationship with periodontal disease, and there is strong evidence that treating one condition positively impacts the other. A shared trait of periodontal disease and these medical conditions is that they are chronic conditions that take a long time to develop and become clinically significant. Primary prevention—treating the patient prior to the onset of symptoms, myocardial infarction, stroke, diabetic complications, or significant periodontal disease—is the challenge. Complications associated with these conditions cause significant morbidity and mortality and are incredibly costly to the healthcare system. Unfortunately, a lack of access to primary medical or dental care prevents some patients from engaging the system until a negative event has occurred. Despite the absence of clear evidence of causality and the direct impact of treatments, the consequences of these chronic conditions for the population are well understood. Dentists, family physicians, and all primary care providers must increase their collaboration and communication to maximize the benefit to patients.

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The oral cavity has been described as “the window to general health.”¹ According to Seymour, statements such as “You cannot have good general health without good oral health” and “The mouth is part of the body” are now considered obvious.² The oral cavity is also the intersection of dentistry and medicine, semi-independent professions that share the same common goal of improving the health and quality of life of patients. At the heart of each profession is the basic concept that appropriate interventions within the framework of that discipline will have an overall positive impact on patients’ health, welfare, and quality of life.³

It has been estimated that more than 100 systemic diseases and upward of 500 medications have oral manifestations, which are typically more prevalent in the older population. Hippocrates reportedly cured systemic conditions by pulling infected teeth.⁴ Despite this, the relationship and impact of oral conditions on systemic conditions has not been fully appreciated until recently.⁴ Is there direct causality between oral and systemic health conditions, or is it just coincidence? This is the main question that may have slowed the understanding of these processes as well as the interaction and collaboration between dentistry and medicine. Bidirectional relationships between oral and systemic conditions are becoming better understood, but more research into this area is needed.⁵ As the impact of oral health on systemic health is clarified and proven, dental and medical professionals need to develop closer ties.

Whether causal or coincidental, the impact and importance of oral health on overall health has been the focus of multiple surgeons general of the United States as well as the World Health Organization.⁶ Access to dental and medical care is a complicated issue; availability of care, cost of care and insurance, cultural issues, and fear are all factors that keep patients out of the office. From a population health perspective, it should not matter who initially examines the patient and identifies a risk factor or early evidence of a disease; what matters is that the patient gets the care he or she needs.

Oral cavity

The mouth and oral cavity are focal points for the interaction of the body with the external environment. Speech, chewing, swallowing, and the early stages of digestion are all vital physiological functions that involve the oral cavity, and the mouth plays a role in psychological identity.⁷

There are multiple surface types in the oral cavity, and each is colonized with a unique population of 500-700 species of bacteria, viruses, fungi, and protozoa, a good number of which are significantly virulent and many of which have not been cultivated.⁸⁻¹² The level of oral hygiene significantly impacts the makeup of the oral microbiome. Individuals with good oral hygiene tend to have a simple flora dominated by gram-positive

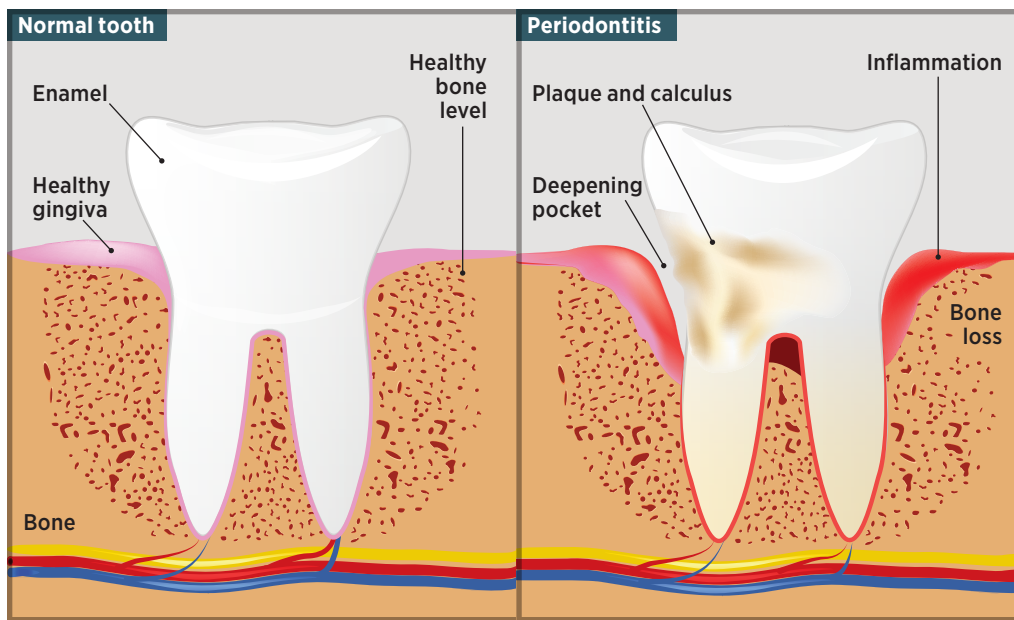


Figure. Development of periodontal disease.

cocci and rods and some gram-negative cocci, while those with poor oral hygiene have a shift to a more diverse and complex flora dominated by anaerobic gram-negative organisms.⁹

The oral cavity is also bathed in a complex mixture of fluids, composed primarily of saliva and gingival crevicular fluid, that plays a major role in maintaining a healthy oral environment.^{9,13} Saliva, like many other bodily functions, has an optimal range; underproduction (xerostomia), overproduction (sialorrhea), and alterations in chemical makeup can lead to bidirectional impacts on health.

Bacteria and saliva play a direct role in the development of the dental biofilm, which is commonly referred to as *plaque* in the lay community. Currently, there is a better understanding that not all plaque is bad and that the interrelationship between saliva and bacteria can protect the teeth by helping maintain mineralization and reducing exposure to dietary acid.¹⁴ The initial bacteria attach to salivary molecules that are absorbed on the tooth surface. The bacteria multiply and lay down a polymer matrix that serves as the framework for more bacteria to attach themselves. A commensal microflora of streptococcal species characterizes the biofilm associated with healthy teeth and gingiva. These organisms prove to be beneficial by interfering with the colonization of more pathologic species.⁹ However, a disruption in the oral ecosystem (*dysbiosis*) can lead to the predominance of carbohydrate-fermenting gram-positive species, which leads to tooth demineralization, thereby beginning the process of oral pathosis.^{11,12}

Oral pathology

Oral pathology is a broad topic, but this article will focus on the oral conditions that have an established or accepted relationship with systemic health: caries and the periodontal diseases of gingivitis and periodontitis. Dental caries is probably the most common infectious disease across humanity. The prevalence varies across

different populations, as public water fluoridation programs have greatly impacted the disease in those areas where it is available, but caries still occurs in epidemic proportions in disadvantaged areas.⁹ Caries is a polymicrobial disease that results from the breakdown of dental enamel by lactic acid that is created when cariogenic bacteria in the biofilm digest dietary fermentable carbohydrates.

Periodontal diseases are a group of chronic immune-inflammatory diseases caused by the bacteria in the biofilm and primarily affecting tooth-supporting structures. Gingivitis and periodontitis are two forms of periodontal disease that exist on a spectrum ranging from bleeding, erythematous, and inflamed gingival tissue to the loss of attachment and alveolar bone.^{7,15} Gingivitis, the milder form of periodontal disease, is characterized by local erythema, swelling, and easy bleeding. Gingivitis is usually pain free; as a result, patients can go years without diagnosis of the disease, but it is easily treatable once identified.^{1,9,10}

Periodontitis, the loss of connective tissue and bone, is the result of chronic inflammation caused by the persistent presence of pathologic bacteria in the biofilm (Figure).^{1,10} The bacteria accumulate in pockets and pull the gingiva away from the teeth. This process triggers the body's immune response, which leads to damage to the supporting structures. Periodontitis is a leading cause of tooth loss around the world.^{1,10}

Systemic conditions impacted by oral health

The benefits of good oral health are well studied and include economic, social, psychological, and physical health.¹⁶ Garcia et al reported that the greater the number of missing teeth, the poorer the quality of life.¹⁷ Poor dentition also leads to issues with chewing and can negatively impact nutritional intake. These relationships are obvious, but the significant impact and relationship of oral and serious systemic conditions are areas that call for increased collaboration.

Chronic health conditions create a massive burden on the health of individuals as well as the entire healthcare system. Routine and regular dental care not only prevents periodontal disease but also helps to stratify patients who are at significant risk for more serious systemic conditions. It has been estimated that 75% of baby boomers will enter long-term care facilities with the majority of their natural teeth, and it is well understood that patients with good oral care require fewer healthcare dollar expenditures.⁶ Among the systemic conditions that are impacted, either coincidentally or causally, by oral conditions are atherosclerotic disease, pulmonary disease, diabetes, pregnancy, birth weight, osteoporosis, and kidney disease.

Atherosclerotic disease

Atherosclerosis, the pathologic narrowing of arteries due to the deposition of cholesterol and cholesterol products in vessel walls, is the primary cause of most cases of coronary heart disease and cerebrovascular disease.¹⁸ Studies done many years ago have shown that patients with a history of myocardial infarction or cerebrovascular attacks have worse oral health than control individuals.^{18,19} Annually, cardiovascular disease accounts for approximately 32%-50% of deaths in the United States and 29%-31% worldwide and may be one of the best-studied relationships between oral health and systemic health.²⁰⁻²² Elevated blood cholesterol, hypertension, diabetes, and smoking are the traditionally discussed risk factors for cardiovascular disease. Growing bodies of evidence indicate that chronic inflammation, metastatic infection, and vascular injury from endotoxins are possible oral cavity-based etiologies of cardiovascular diseases.²³

Patients with periodontal disease and poor oral hygiene suffer from frequent and severe gingival inflammation and frequent bacteremia, both of which activate the host inflammatory response.^{5,10,20} This chronic inflammatory state triggers multiple proinflammatory cytokines, such as C-reactive protein, tumor necrosis factor α , interleukin 1 β , and interleukin 6, which, in conjunction with bacteremia, appear to stimulate the process of atherogenesis as well as increase the susceptibility of the vascular endothelium for injury (a precursor to atherogenesis). In addition, during episodes of dental bacteremia, streptococci of the viridans group can induce platelet aggregation and possibly thrombus formation. Atherosclerotic cerebrovascular disease plays a major role in the etiology of cerebrovascular accidents (strokes) and transient ischemic attacks.^{5,10,20}

While several studies have demonstrated that periodontal disease and poor oral hygiene have a strong association with the risk of coronary heart disease and acute myocardial infarction, other studies have not shown this link; as a result, there is insufficient evidence to prove a causal link between them.^{17,20} There is better evidence to support the causal relationship between poor dental health and cerebrovascular disease.¹⁸ Can a patient's risk of heart disease and stroke be reduced by treating periodontal conditions and improving oral health? From a population health standpoint, with the high prevalence of each condition, it would be a major benefit to know that improving oral health would reduce the risk of conditions with significant morbidity and mortality. Similar to the causality data, the intervention data

are not conclusive, but current research is trending in favor of the interpretation that improvement of oral health decreases the risk of atherosclerotic disease.²⁰

Pulmonary disease

Pulmonary diseases such as pneumonia, chronic obstructive pulmonary diseases (including emphysema), and exacerbations of chronic bronchitis all involve the aspiration of bacteria from the oropharynx into the lower respiratory tract.⁵ At one time, it was thought that only patients with endotracheal and orogastric tubes, swallowing disorders, and impaired consciousness were at risk of aspiration. However, studies have shown that up to 50% of healthy individuals aspirate oropharyngeal contents while asleep.¹⁷

The teeth, periodontium, and biofilm all can harbor and serve as reservoirs for pathologic bacteria, and the presence of periodontal disease changes the milieu, making it easier for pathogens to attach and multiply.²⁰ The development of an infection is multifactorial and depends on more than just the presence of bacteria, as the body has multiple echelons of defense to prevent bacteria from seeding the lower respiratory tract. These defenses are limited in patients who are critically ill and intubated, and multiple intervention studies have shown that improving the oral hygiene of ventilated critical care patients decreases the risk of ventilator-associated pneumonia.^{17,18}

The evidence on the causality and relationship between pulmonary infections and oral health is inconclusive but trending toward a positive unidirectional relationship. Many high-quality studies have shown that improving the oral hygiene of institutionalized and ventilated patients has a positive outcome on their systemic health.¹⁰

Diabetes mellitus

Diabetes is a disease of disrupted glycemic control resulting from a lack of insulin production (type 1) or systemic insulin resistance (type 2). In 2008, it was estimated that 18 million people worldwide had diabetes.²⁰ Diabetes presents multiple challenges to the patient, and prolonged exposure to hyperglycemia is the primary cause of the litany of complications created by diabetes. Prolonged hyperglycemia has negative effects on the heart, eyes, kidneys, and peripheral nerves, and researchers now suggest that periodontal disease should be considered a major complication of diabetes.^{15,24}

The relationship between diabetes and periodontitis is truly bidirectional, as it is well proven that hyperglycemia negatively impacts oral health and severe periodontitis can negatively impact glycemic control.^{20,25} Individuals with diabetes have at least a 3 times greater risk of periodontitis than those without diabetes.^{1,10} However, studies have shown that patients with well-controlled diabetes have no increased risk of periodontitis compared to individuals without diabetes.^{1,10}

Gingival pockets that are deeper than 4 mm are more common in diabetics than nondiabetics, and patients with pockets greater than 2 mm deep are at an increased risk of diabetes compared to patients with pockets less than 1.3 mm deep.¹⁸ Individuals with diabetes also suffer from greater amounts of alveolar bone loss, abscess formation, and poor healing.¹⁸ Why do diabetics have all of these oral complications? The prolonged exposure to

hyperglycemia results in the production of advanced glycation end products.²⁰ Advanced glycation end products have a systemic impact that results in the increased excretion of cytokines, leading to local inflammation and a loss of connective tissue. Local inflammation in the mouth has a systemic effect—glycemic control is more difficult, and the risk of infection is increased—explaining the bidirectional relationship of the condition.⁵

Although periodontal disease can have negative adverse effects on diabetes, its impact is modifiable and treatments can greatly improve the health of the patient. Multiple studies have looked at the best way to treat periodontitis and positively impact glycemic control.^{20,26} The combination of mechanical removal of the biofilm and use of oral antibiotics has the greatest impact on glycemic control and periodontal disease in diabetic patients.²⁰ Aggressive prevention and treatment of periodontal disease in diabetic patients is an effective way to mitigate the medical complications of this chronic disease.²⁶

Pregnancy complications and low birth weight

Pregnancy is a time of great change in a woman's body, and the changes impact both the oral cavity and the maternal-fetal complex. Gastric acid secretion and the reflux of the acid into the oral cavity leads to worsening of enamel erosion, increased caries risk, xerostomia, and increased tooth mobility and loss.²⁷ Although pregnancy is a normal condition, non-obstetric providers are often hesitant to care for pregnant patients out of concern for the potential impact on the pregnancy. It is estimated that between 22% and 34% of pregnant women will consult a dentist while pregnant, and only 50% of women would address an oral issue while pregnant.²⁸ Despite the fact that there is some good evidence that oral conditions can negatively impact pregnancy (increasing the incidence of preeclampsia, low birth weight, stillbirth, and spontaneous abortions), there are no guidelines for the management of oral condition in pregnant women.^{28,29} To reassure patients and providers, it might be time for professional societies to join forces and create some guidelines for addressing conditions that are known to impact the mother and her unborn fetus.

The changes in the gingiva that occur during pregnancy are associated with the changes in estrogen and progesterone levels. These hormonal changes are most dramatic between the second and eighth months of pregnancy, and the gingival changes coincide with this period. The hormones cause capillary dilation that results in gingival hypertrophy and inflammation. Subsequent to the changes in the gingiva, there is a change in the oral flora, including an increase in the amount of anaerobic bacteria. These anaerobes initiate an inflammatory process that has systemic impacts.¹⁷ This distant oral infection triggers an inflammatory process similar to bacterial vaginitis, resulting in myometrial contractions and preterm birth.⁵

Preterm, low-birth-weight infants are probably the best-studied obstetric complication of periodontal disease; the presence of periodontal disease in the mother results in a 7.5 times greater risk of this complication.¹⁸ Unfortunately, the data on the impact of treating periodontal disease during pregnancy are mixed. Multiple systemic reviews have been completed, and some show a positive impact if periodontal disease is treated

while others show no change or a less than statistically significant change.^{10,27} Despite the lack of solid evidence, it is intuitive that anything that optimizes the health of the mother and the fetus is beneficial. It would be prudent for women who are planning a pregnancy, especially those with known periodontal disease, to consider undergoing a thorough periodontal examination and necessary treatment.²⁸

Other conditions

In osteoporosis, an imbalance between bone loss and formation results in decreased bone mineral density. Decreased bone density in the jawbone leads to greater alveolar bone resorption, increasing the depth and number of gingival pockets, which in turn allows invasion by periodontal pathogens.²⁰ This chronic infection leads to local and systemic increases in interleukin 6, which is a known predictor of bone loss. As with many of the conditions already discussed, it is impossible to state that periodontal disease is causal to osteoporosis, but the studies seem to lean toward a positive relationship between the conditions.^{5,20} Currently there is no strong evidence to suggest that treating periodontal disease will have an impact on osteoporosis.^{5,20}

Periodontal disease and other conditions that result in poor oral health are common in patients with chronic kidney disease. These oral conditions can lead to systemic inflammation, infection, protein wasting, and the development of atherosclerotic lesions, all of which worsen morbidity and mortality in chronic kidney disease patients. It is unclear whether treating periodontal disease will positively impact patients with chronic kidney disease, but optimizing the patient's overall health cannot have a negative impact.³⁰

Conclusion

Optimization of patients' health is the goal of both the medical and dental professions. Atherosclerotic vascular disease, pulmonary disease, diabetes, and pregnancy-related complications are the major conditions that effect a large percentage of the population and have been well studied for their relationship to oral health, but it is probably safe to assume that there are other conditions that have some degree of association. Although many of the studies on treatment of oral disease have not shown a statistically significant impact on these systemic conditions, neither profession will deny that maximizing a patient's health is advantageous.

Primary prevention of disease is the best approach but often difficult to achieve. From a primary care standpoint, it is vital that physicians and dentists increase collaboration and share information that can impact the patient's health. Most patients with these chronic conditions probably do not think that a problem in their mouth can affect their heart or bones. Modifying any coexisting condition may be enough to prevent a significant, possibly life-threatening medical outcome.

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