Analysis of Periodontitis: Treatments, Prevention, and Advances in Current Research

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Abstract

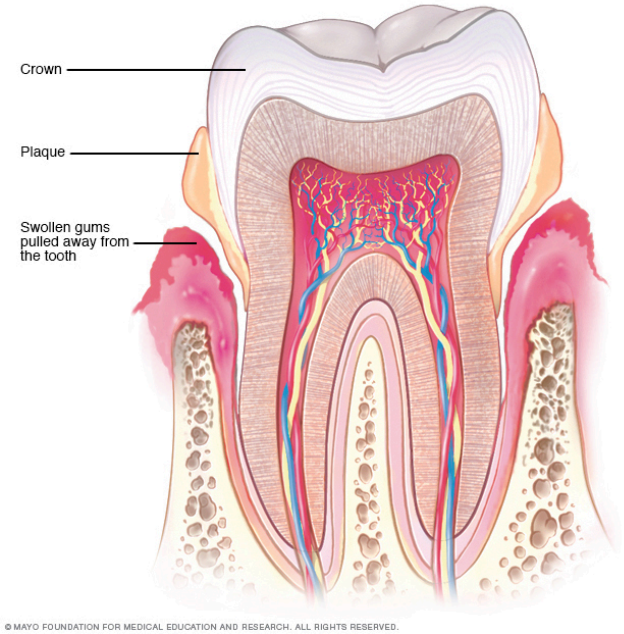
Periodontitis is a chronic inflammatory gum disease that damages the tissues surrounding and supporting the teeth. It is primarily caused by the accumulation of bacteria on the teeth and the biofilm and environment that they form. One major symptom of this disease is swollen and bleeding gums as well as damaging inflammation. Current treatment for periodontitis includes professional deep cleaning by a dentist to remove tartar, antibiotic treatment in some cases, or even surgery in some cases. If left untreated, periodontitis can lead to tooth loss and bone loss as well as increased risk for other health issues such as heart disease or stroke. Periodontitis is preventable and really only requires that the gums and teeth are taken care of, through things like daily brushing and flossing of teeth. However, it has been found that it has a genetic and hereditary component that may impact certain individuals. Periodontitis affects over 40% of adults in the United States as well as a large number of individuals internationally, and due to the subsequent health issues it can cause, research on the disease is very necessary. There is lots of current research on periodontitis and all of the correlations between it and other diseases, however more research can be done and will continue to be done as long as this disease remains. As the dental and medical fields progress, especially technologically, understanding diseases like this one will remain important.

Introduction

Gum diseases are very common infections that affect many different people at some point during their lives. Two of the most common gum diseases are gingivitis and periodontitis. Gingivitis is a mild form of gum disease that causes irritation and redness on the outer gums. If left untreated, gingivitis can lead to periodontitis. Periodontitis is an advanced and serious gum infection that damages the deep tissue that surrounds and supports the teeth. It is triggered by bacterial microorganisms that create plaque and tartar on the teeth, and causes chronic inflammation that spreads deep below the gums and along the roots of the teeth (Mayo Foundation for Medical Education and Research, 2023). This can cause permanent damage and can lead to irreversible bone and tooth loss. In fact, approximately 700 species of microorganisms can exist in the oral cavity. While most of them are commensal, there are many that can be harmful, and these are the ones that fuel periodontitis (National Library of Medicine, 2023). Periodontitis can also lead to more intense health problems down the line such as heart disease, hypertension, cerebrovascular disease, and more (European Federation of Periodontology, n.d.). Periodontitis is one of the very most common diseases associated with the oral environment and mouth. It is very important that periodontitis is treated in an efficient, effective, and timely manner as it not only affects the mouth and bone, but the subsequent health problems it can cause can be very serious, and impact the overall systemic health very significantly (Implantology, Department of Periodontology, 2023). Other lifestyle choices such as smoking or a bad diet can also impact periodontitis and worsen it greatly.

Figure 1

Anatomy of Tooth & Gums with Periodontitis

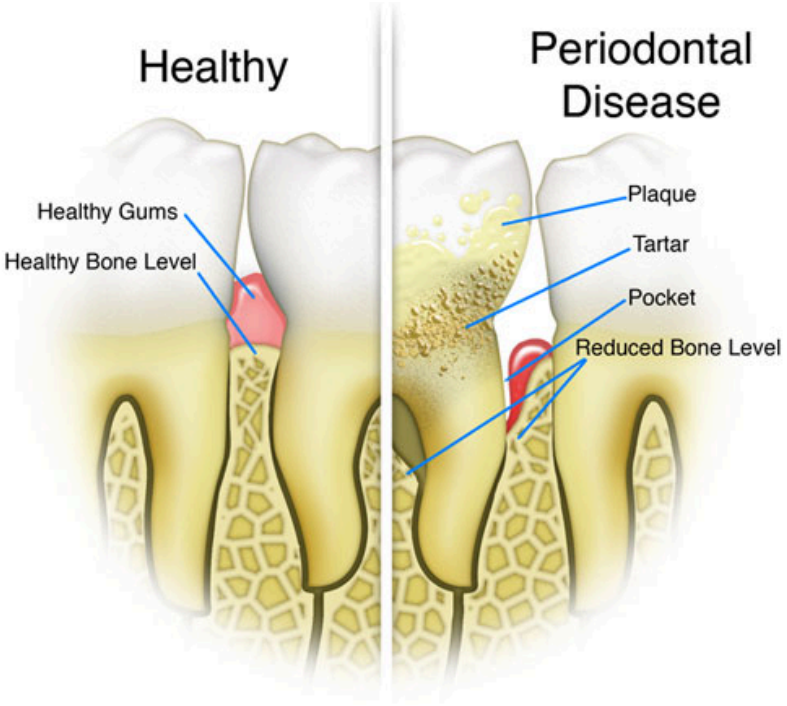


Note. Tooth anatomy consists of the crown, dentin, and pulp. The crown is the outer layer of the tooth that is visible. A hard, very protective substance called enamel covers the crown. Underneath this is the dentin. This is also a strong and protective material, but it is not quite as strong as enamel. If enamel is missing and the dentin is exposed, this increases the risk of cavities. The pulp is the innermost layer of the tooth, and it contains nerves, blood vessels, and connective tissue (Cleveland Clinic, 2023). This figure shows the plaque on the outside of the crown and how it has impacted the gums, causing swelling and detaching. It is also visible in this figure that the dentin is beginning to be exposed.

There are current treatments that are typically used for tackling periodontitis. There are six main stages that result in a successful treatment. The first is delivery of oral hygiene advice and instruction. The aim of this stage is to reduce the amount of bacteria in the mouth and in turn reduce the occurring inflammation. The second stage is professional cleaning in which all of the plaque and tartar are removed from the outer areas of the teeth. In cases of advanced periodontitis, multiple cleanings may be necessary. The third stage is antibiotic therapy. In cases in which a subsequent infection is present, antibiotics may be necessary. The fourth stage is reassessment. After around 6-8 weeks, the dentist will assess the gums to check the progress of the treatments done thus far. There is an instrument called a periodontal probe that can be used to record the depth of any gaps or pockets as well as check for bleeding in the gums. Any gaps or pockets in the gums that exceed 3mm signify that further treatment may be necessary.

Figure 2.

Healthy Gums vs Gums with Periodontal Disease



Note. In this figure, the periodontal pocket is visible on the side showing periodontal disease. This is where the probe would be entered for assessment.

Figure 3.

Periodontal Probe

Note. The black lines shown on the probe in the figure above are what allows the dentists to determine the depth of gaps and pockets as well as the severity of the disease progression. In this image the redness and inflammation are also visible in the affected areas of the gums.

In the case that periodontal pockets do exceed 3mm, the process moves on to stage 5 which is corrective surgical therapy. The procedure removes plaque bacteria and deposits within the pockets as well as on the root surfaces where the roots diverge. Brushes and floss cannot access these deep areas, so the harmful bacteria and subsequent inflammation will remain until removed. This procedure is performed under local anesthesia and consists of the gum being raised and root surfaces cleaned to ensure all the buildup is gone. In certain cases, the bone also needs to be remodeled. Another possible type of treatment for these types of cases is regenerative periodontal therapy. This type of therapy involves using bone-replacement grafts or proteins to reconstruct the bone that has been lost from periodontitis. After the gums are cleaned out, they are stitched back into place around the teeth. The final sixth stage is aftercare and supportive periodontal therapy. The long term success of periodontitis treatment depends on the patients continuing oral hygiene as well as follow ups and care from their dentist. It is important that the condition of the gums is reviewed in regular intervals to check that inflammation has actually halted (European Federation of Periodontology, n.d.).

Periodontitis can be prevented if the teeth and gums are taken care of. Having good habits in oral hygiene is extremely important as well as getting professional checkups throughout each year from the dentist. Gum inflammation cannot develop if there is no bacteria or plaque present on the teeth, and therefore periodontitis also cannot develop if the gums and teeth are taken care of properly. The number one thing to prevent periodontal disease is frequent brushing and flossing of the teeth. If these habits are kept up with, then disease should not develop. Also, things like

smoking and diet can play a preventative role if monitored. Another great option is to get an annual CPE. A CPE is a comprehensive periodontal evaluation in which a periodontist looks at the teeth and gums in general, plaque levels, bite, and any possible risk factors for periodontitis. If symptoms of gum disease are identified early then that can also really help with prevention (American Academy of Periodontology, 2020).

While there are these current treatment stages and options for periodontitis, the subsequent health issues they can cause may still be severe. Furthermore, new technology is still developing and there may be future treatments for the more advanced cases that do not even require surgery. Research is still necessary regarding periodontitis due to these reasons.

Discussion

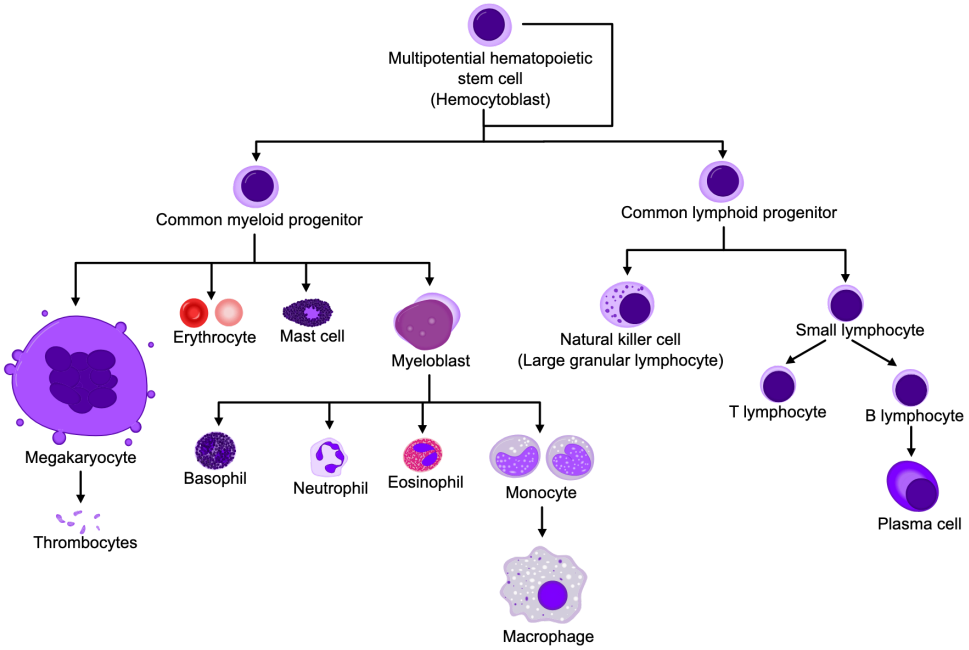
There is lots of current research in the dental field and technology has greatly progressed over the years. There is also lots of current research about periodontitis specifically. However, periodontitis affects over 40% of adults in the United States and its true genetic markers and implications are really not known. Also, it can lead to many other manifestations and subsequent infections or diseases in which the mechanisms should be understood. It is very important to both dentists and physicians to understand how an oral disease such as this one can impact overall systemic health.

There is a crossroads between periodontitis and hematologic diseases. There are many examples of red blood cell disorders affected by periodontitis, such as aplastic anemia and sickle cell anemia, as well as white blood cell disorders affected by periodontitis, such as cyclic neutropenia, maladaptive trained immunity, clonal hematopoiesis, leukemia, and myeloma. The inflammation that periodontitis inflicts can majorly affect the hematopoietic system. This is because the inflammation signals excessive release of pro-inflammatory cytokines and mediators into the blood, triggering immune response and stress. This in turn can affect production of blood cells, leukocytes, and platelets, and lead to further disorders. Further, the presence of the bacteria that lead to infections can also impact the hematopoietic system if they enter the bloodstream as they can lead to bacteremia and complications. Additionally, long term treatment of periodontitis can lead to significant reduction in blood inflammatory markers, which supports the idea that maintenance of oral hygiene improves overall health (International Journal of Molecular

Sciences, 2024). There have also been findings connecting periodontitis to hematologic cancer. In a study from 2024, researchers found a significantly lower incidence of hematologic cancer in individuals that did not have chronic periodontitis. Therefore, the periodontal microbiome and symptoms may play a large role in facilitation of cancer and direct migration of microbes throughout the body (MDPI, 2024). This also could lead to an effect on patient response to treatments. It is important to understand the bridge between these two associations so that dentists can better understand the links to other diseases and how better to treat patients.

Figure 4.

Hematopoietic System



Note. The hematopoietic system refers to the entire system in the body that produces blood. It includes

many organs such as the spleen, thymus, lymph nodes, kidneys, liver, and more. A malfunction in the hematopoietic system can cause many problems and diseases in the body.

Recent studies have also suggested that periodontitis may have a strong correlation with high blood pressure and hypertension (AHA Journals, n.d.). Systemically healthy adults that experience periodontitis have shown a higher mean SBP and DBP than controls in the study without periodontitis. In turn, a higher blood pressure increases the risk of heart failure, kidney disease, atrial fibrillation, heart valve problems, aortic syndromes, and even dementia. Further, the excessive bleeding that can come from periodontitis also played a role in this. Going even more off of this, there have been studies relating periodontitis to cardiovascular disease and myocardial infarction, or heart attack (American Heart Association, n.d.).

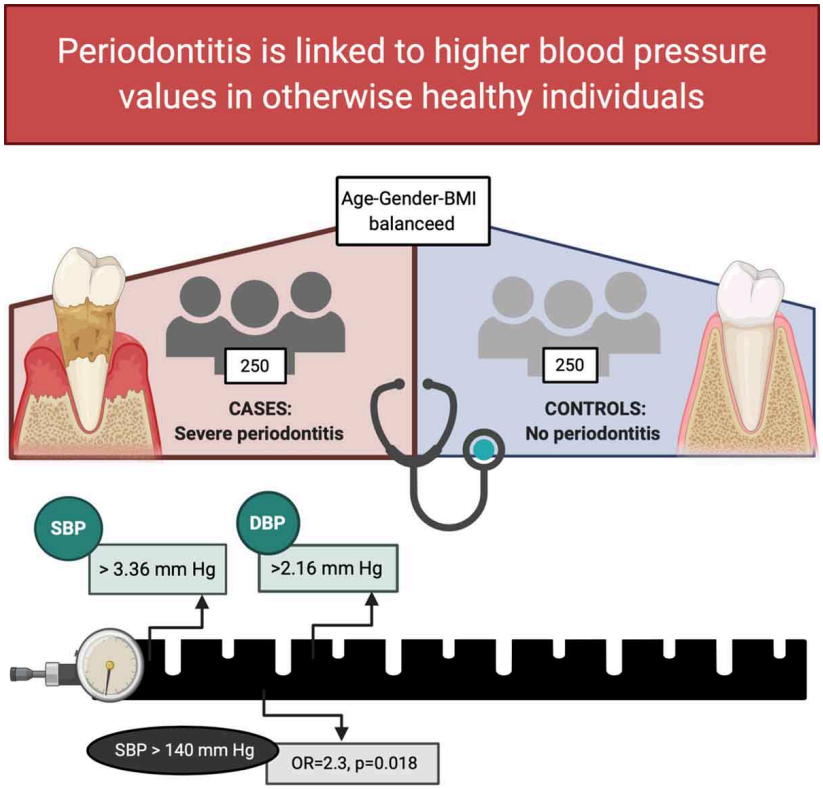
Figure 5.

Periodontal Bleeding

Note. This figure shows an example of periodontal bleeding. This bleeding can contribute to blood pressure and heart problems. It can also impact the immune response, furthering the infection. This figure helps show more of what the bleeding might look like as it comes out of the deep gaps within the gums and between the teeth.

Figure 6.

Periodontitis & Blood Pressure

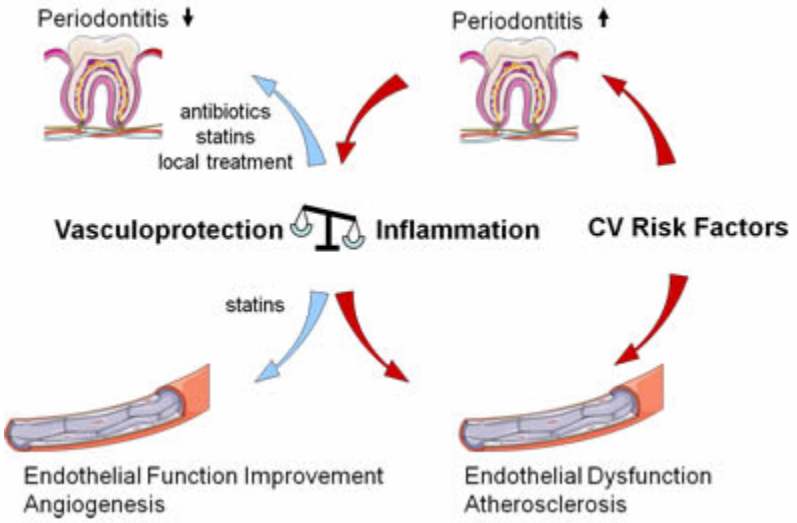


Note. This figure demonstrates the link between periodontitis and high blood pressure. It illustrates the case of severe periodontitis versus no periodontitis in healthy individuals.

In another study, it was found that individuals with periodontitis have different concentrations of proteins in their blood. More specifically, individuals with periodontitis have significantly reduced levels of EGF, or epidermal growth factor, a protein that is very crucial to wound healing. These findings are especially important because they provide a path for future research into biomarkers in blood for periodontitis and the true underlying causes of the disease. Researchers can look into drugs that could specifically slow down disease progression for those who are on the route to severe bone loss and other health issues (ScienceDaily News, 2024). Periodontitis can impact atherosclerosis. Going further off of this, it may negatively impact blood vessel walls. Atherosclerosis is a systemic inflammatory disease that can be very harmful and is actually the leading cause of death in Europe (European Society of Cardiology, n.d.).

Figure 7.

Periodontitis and Atherosclerosis

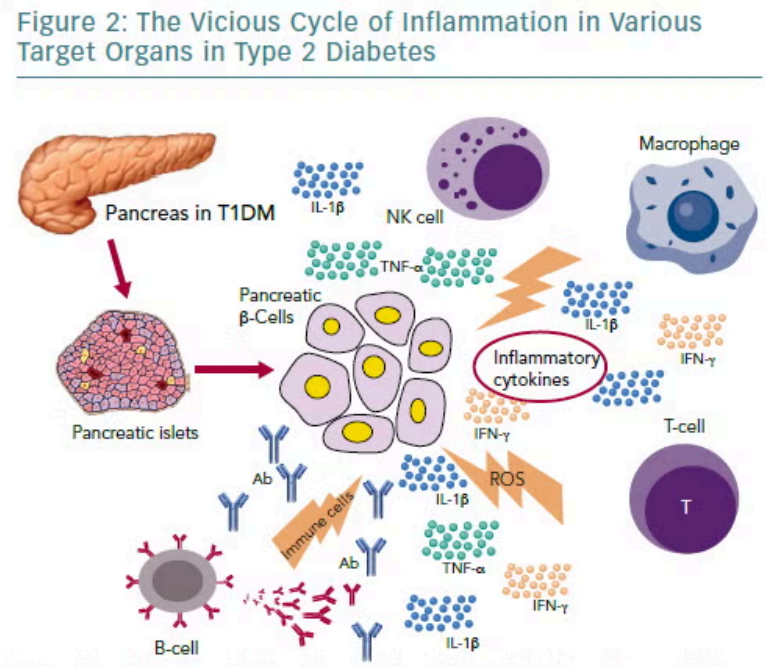


Note. This figure helps show the mechanism of how periodontitis and atherosclerosis interact.

Another very important disease that periodontitis has an impact on is diabetes. Diabetes is a chronic disease that impacts how the body is able to convert and use glucose. There are two types: type 1 and type 2. Type 1 is an autoimmune disorder where the immune system attacks and destroys pancreatic cells that produce insulin. Type 2 is more common in which the body cannot use insulin well, and this type is impacted by lifestyle choices. Diabetes, especially type 2 is majorly impacted by inflammatory conditions, so periodontitis is no exception to having an impact on this disorder. There is a relationship between glycemic control and oral health in individuals that have diabetes. In a study, it was found that patients with diabetes experienced a much higher prevalence of periodontitis than those individuals without diabetes.

Figure 8.

Inflammation and Diabetes



Inflammation has a key role in the pathophysiology of type 2 diabetes and its associated metabolic abnormalities.

Note. This figure shows how inflammation can impact the pathophysiology of diabetes. The increased inflammation that already comes with diabetes speeds up the proliferation of periodontitis and can make it much worse.

There has also been a correlation between periodontitis and uric acid levels in blood. (BioMed Central, 2023).

The microbiology behind the disease, the bacteria that inhabit the infected areas in periodontitis, are also extremely important. For periodontal disease to occur, it requires not just one pathogen, but a network of interplay between multiple bacteria for the disease to really proliferate and cause problems. In one specific study from 2021, it was found that the bacteria *Porphyromonas gingivalis* leads osteoclastic differentiation as it regulates certain ligands and inhibits noncommitted osteoclast precursors. This essentially means that it creates an immune suppression system that benefits persistence of periodontitis and compromises the host. This combination of bacterial growth along with periodontitis proliferation has a correlation with increased bone loss (Springer Link, 2021). Another bacterium, *Fusobacterium nucleatum,* is seen as a very important bridging organism for maturing biofilms on the teeth. This means it helps allow other species with virulent properties to further colonize the area and help periodontitis progress more. Recent evidence has shown that *F. nucleatum* induces an environmental change in the mouth through hypoxia which supports colonization of pathogens in the biofilm and also induces an inflammatory state (MDPI, 2019). It is also important to note that different plaque

samples from different periodontitis patients may yield a different microbial community. For example, *Porphyromonas gingivalis* as mentioned above is one of the most common, but others like *Tannerella forsythia*, *Treponema denticola,* and *Filifactor alocis* are also relatively common. In the very aggressive occurrences of periodontitis, *Aggregatibacter actinomycetemcomitans* was found to be an established periodontal pathogen. However, the list of various pathogens that have appeared in periodontitis cases is very large (MDPI, 2019).

One example of a technological advancement regarding periodontitis is the use of a 980 nm laser as a nonsurgical treatment in chronic periodontitis. This method would be much less invasive for patients and could provide an easier and more desirable treatment option for periodontitis patients. Further, in more severe cases it could allow the damage to not become worse. (Global Journal for Research Analysts, 2022).

Modern research of periodontitis has brought up more niche and specific topics. One study looked at the levels of soluble receptor activators of a certain nuclear factor ligand in the gingival crevicular fluid (GCF) in smokers and nonsmokers with periodontitis. The conclusions drawn were that smokers with periodontitis had higher GCF concentration, meaning that smoking does have a correlation with the proliferation of periodontitis (The Journal of Contemporary Dental Practice, n.d.). One more modern and very interesting study that was completed was one that tested the use of ozonated olive oil as a subgingival irrigant to treat chronic periodontitis, both microbiologically and clinically. Researchers tested the ozonated olive oil in chronic

periodontitis patients and then measured the plaque indexes, gingival indexes, and probing depths afterwards. It was found that it reduced the microorganisms and plaque as well as helped with the periodontal pockets. Something like this could be game changing for periodontitis treatment as it was quick and very effective (World Journal of Dentistry, n.d.). In another study, circRNA was applied in biomaterial delivery to provide new directions for vaccine development and halting of periodontitis progression and even potential reversal. There are current emerging therapies like small molecules and mRNA treatments, but they fail to really target the inflammation periodontitis brings. Therefore, there is a need to explore more advanced ideas and methods for this. The innovative nanozyme that this study used was extremely efficient at delivering circular RNA and could be huge for periodontal studies especially for this disease specifically (Chemical Engineering Journal, 2024). Lastly, there was a very interesting study that assessed a tree shrew as an animal model for the further study of periodontitis. Tree shrews are evolutionarily closer to humans than normal mice used in research, so they can provide a better understanding of the disease and its components. Researchers found that when put under certain conditions, tree shrews experienced accurate periodontitis symptoms, making them promising as this type of animal model. (Journal of Clinical Periodontology, 2023).

Summary & Conclusions

Periodontitis is a disease driven by continuing infection in which the oral microbiome plays a large role. Excessive plaque deep in the tissue initiates a large inflammatory response and can lead to many consequences in the body as well as subsequent diseases and infections. It can also lead to irreversible bone damage or loss.

In terms of future research, while there has been promising evidence that periodontitis has a strong hereditary and genetic component, there are currently not any methods to predict individuals predisposed for this disease and the specific involved genes are not known. Therefore, I think it would be very beneficial to investigate this specific aspect of periodontitis more as it could really help with the understanding of the disease. For simpler methods of helping periodontitis, I think further education could be spread about it. It could be better explained to all individuals at their routine check ups.

Overall, periodontitis is a common and important disease that deserves a lot of attention. It can be prevented, but if left untreated can become very serious. While there are currently sufficient treatments, it still requires much research before it is fully understood.

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