Fusion of Multidisciplinary research, an international journal, Vol. **4**, Iss. **2**, 2023
https://doi.org/10.63995/PUCI6114

FMR

ARTICLE

Periodontitis: Causes, Symptoms, and Steps to Treatment

George Jonesn, Hayden Wilson, Sebastian Smith,* and Taylor Brown

Department of Oral Sciences, School of Dentistry, University of Otago, New Zealand
*Corresponding author: sebastian.sm29@otago.ac.nz

(Received: 16 February 2023; Revised: 02 May 2023; Accepted: 17 June 2023; Published: 03 July 2023)

Abstract

Periodontitis is a severe gum disease that affects the tissues supporting the teeth, leading to tooth loss if untreated. The primary cause is the accumulation of plaque, a sticky film of bacteria on teeth, which, if not removed through regular brushing and flossing, hardens into tartar. This buildup triggers an inflammatory response, damaging the gums and the bone supporting the teeth. Other contributing factors include poor oral hygiene, smoking, genetic predisposition, certain medications, and systemic conditions such as diabetes. Symptoms of periodontitis include swollen, red, and bleeding gums, persistent bad breath, gum recession, and loose teeth. As the disease progresses, pockets form between the teeth and gums, harboring more bacteria and exacerbating the condition. Treatment for periodontitis involves several steps. Initially, a thorough professional cleaning, known as scaling and root planning, is performed to remove plaque and tartar from below the gum line. Antibacterial medications may be prescribed to control infection. In advanced cases, surgical interventions such as flap surgery or bone and tissue grafts might be necessary to restore damaged structures. Maintaining strict oral hygiene practices, regular dental check-ups, and lifestyle modifications, such as quitting smoking, are crucial in managing and preventing the recurrence of periodontitis. Early detection and treatment are key to preserving oral health and preventing tooth loss.

Keywords: DentalHygiene;GumDisease;OralHealth;PlaqueBuildup;ToothLoss;TreatmentSteps

Abbreviations: ANUG: Acute Necrotizing Ulcerative Gingivitis

1. Introduction

Periodontitis, a severe gum disease, affects the tissues surrounding the teeth, leading to destruction of the supporting structures and eventual tooth loss. Its primary cause is a mixed bacterial colonization in the oral tissues, forming a complex biofilm. While periodontitis primarily stems from poor oral hygiene, certain factors like diabetes, smoking, and conditions like leukemia can increase one's risk. This paper delves into the symptoms, stages, causes, diagnosis, and treatment options for periodontitis. It explores non-surgical interventions like scaling and root planing, as well as surgical procedures like flap surgery and bone grafting. Additionally, it discusses preventive measures, potential complications like tooth loss and systemic effects on overall health, and the outlook for individuals affected by this condition (Fig. 1) [1, 2, 3, 4, 5, 6, 7, 8, 9].

2. Symptoms

Periodontitis, a progressive gum disease, manifests itself through various symptoms that can initially be mild but worsen over time if left untreated [10, 11, 12]. The earliest stage, known as gingivitis, is

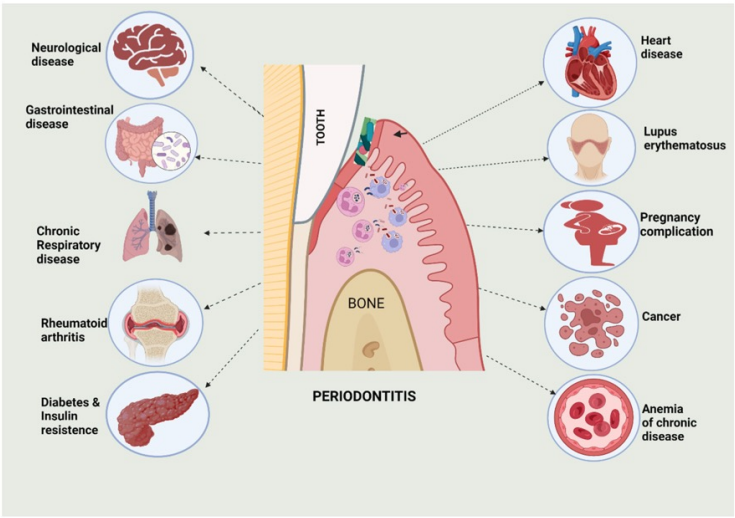

Figure 1. Representation of diverse systemic diseases and their relationship with periodontitis.

characterized by (Fig. 2):

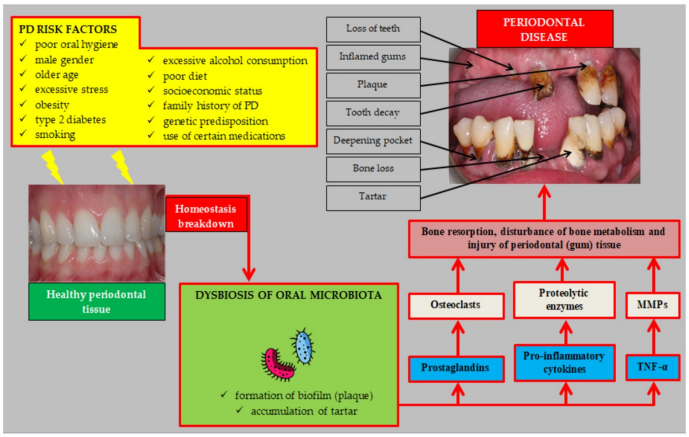

Figure 2. Etiopathogenesis of periodontal disease.

- Inflammation around the gums, causing them to appear red and swollen
- Gums that bleed easily during brushing or flossing

As the condition progresses to periodontitis, more severe symptoms may arise, including:

1. **Gum Abnormalities:**
   - Swollen or puffy gums
   - Bright red, dark red, or dark purple gums
   - Gums that feel tender when touched.
2. **Bleeding and Discharge:**
   - Bleeding gums, especially during brushing or flossing.

- A toothbrush that looks pink after brushing, indicating bleeding.
- Spitting out blood when brushing or flossing
- Pus between teeth and gums

3. **Oral Hygiene Issues:**
   - Persistent bad breath (halitosis) that won't go away
   - Unpleasant taste in the mouth
4. **Tooth and Bite Abnormalities:**
   - Loose or sensitive teeth
   - Pain while chewing
   - New spaces developing between teeth, appearing as black triangles
   - A change in the way teeth fit together when biting

In severe cases, individuals may experience acute necrotizing ulcerative gingivitis (ANUG), a rare condition characterized by intense symptoms such as bleeding, painful gums, painful ulcers, receding gums, bad breath, difficulty swallowing or talking, and fever [13, 14, 15, 16, 17].

3. Stages

Periodontitis progresses through several distinct stages, each characterized by varying degrees of severity and tissue damage. Understanding these stages is crucial for timely intervention and effective management of the condition (Fig. 3) [18]:

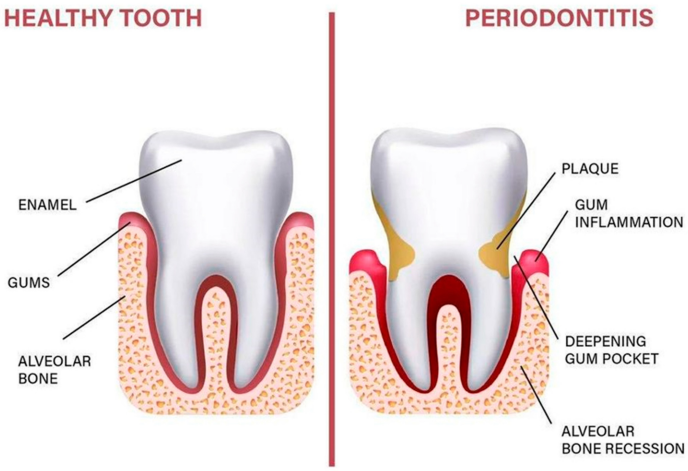

Figure 3. Anatomy of the periodontium.

1. **Healthy Gums:** In a healthy state, the gums are firm, pink, and tightly attached to the teeth, supported by dense underlying bone.
2. **Gingivitis:** This initial stage of gum disease is marked by inflammation and rednessof the gums, which may bleed easily during brushing or flossing. Gingivitis is the mildest and most common form of gum disease and can be reversed with improved oral hygiene practices.
3. **Early Periodontitis:** As the condition progresses, the gums begin to pull away from the teeth, forming "pockets" where food particles, bacteria, and plaque can accumulate, leading to infection. The surrounding bone also starts to deteriorate.

4. **Moderate Periodontitis:** At this stage, inflammation spreads, and some discomfort may occur. More supporting bone is lost, teeth become loose, and gums recede further. Initial periodontitis causes damage to the fibers that join the tooth roots to the socket, and while it can be managed, the damage cannot be reversed.
   - Moderate periodontitis involves more obvious damage to the ligaments and joints between the tooth root and socket.
5. **Advanced Periodontitis:** This advanced stage is a major cause of tooth loss in adults, marked by painful abscesses resulting from the infection spreading beneath the gums.
   - **Severe Periodontitis (Stage 3):** Characterized by loose, drifting teeth, persistent bad breath, and abscesses, this stage requires extensive treatment.
   - **Severe Periodontitis (Stage 4):** Representing the most advanced disease state, this stage involves missing teeth, loose and unstable remaining teeth, and an increased risk of other serious health problems.

It's important to note that periodontitis can progress at different rates – slow, moderate, or rapid – and faster progression requires more urgent treatment [19].

4. Causes

Periodontitis, a progressive gum disease, often stems from poor oral hygiene habits that allow the buildup of plaque, a sticky film composed of bacteria. If not removed through regular brushing and flossing, plaque can harden into tartar (calculus) under the gumline, creating an ideal environment for bacteria to thrive. The persistent presence of plaque and tartar leads to ongoing gum irritation and inflammation, causing the formation of deep pockets between the gums and teeth. These pockets become breeding grounds for more plaque, tartar, and bacteria, perpetuating the cycle of infection and tissue destruction [20, 21, 22, 23, 24].

Several risk factors can contribute to the development and progression of periodontitis:

1. **Standardized Testing Methods:** Inadequate brushing, flossing, and professional dental cleanings allow plaque and tartar to accumulate, increasing the risk of gum disease.
2. **Smoking and Tobacco Use:** Smoking is the most significant risk factor for periodontitis. It impairs the immune system's ability to fight infection, slows healing, and can render treatment less effective.
3. **Hormonal Changes:** Fluctuations in hormones during puberty, menstrual cycles, pregnancy, and menopause can increase the body's inflammatory response, making gums more susceptible to bacterial infections.
4. **Chronic Illnesses and Medications:** Conditions like diabetes, HIV/AIDS, and autoimmune disorders, as well as certain medications, can weaken the immune system and increase the risk of periodontitis.
5. **Genetics:** Some individuals may have a genetic predisposition that affects how their immune system responds to bacteria, making them more prone to gum disease despite good oral hygiene practices.
6. **Other Factors:** Obesity, poor nutrition, stress, and conditions like heart disease can also contribute to the development and progression of periodontitis.

While the bacteria that cause gum disease can be transmitted through close contact like kissing, periodontitis is not highly contagious through brief casual contact [25, 26, 27].

5. Diagnosis

The diagnosis of periodontitis typically involves a comprehensive evaluation by a dental professional, including a thorough examination of the mouth and gums, as well as potential diagnostic tests. The process may involve the following steps:

1. **MedicalandDentalHistoryReview:** The dentist or periodontist will gather information about the patient's overall health, medications, and any existing medical conditions that may contribute to or exacerbate periodontitis..
2. **Clinical Examination:** A visual inspection and probing of the gums will be performed to assess the presence of inflammation, bleeding, and pocket depths around the teeth. Healthy gum pockets are typically 1-3 millimeters deep, while pockets deeper than 4 millimeters may indicate periodontitis [28].
3. **Radiographic Evaluation:** Dental X-rays, such as panoramic or bite-wing X-rays, may be taken to evaluate the bone levels around the teeth and detect any bone loss, which is a hallmark of advanced periodontitis.
4. **Additional Tests** In some cases, further diagnostic tests may be recommended, such as:
   - **Microbiological Testing:** This involves taking samples of plaque or gum tissue to identify the specific types of bacteria present, which can help guide treatment decisions.
   - **Genetic Testing:** Certain genetic factors can increase an individual's susceptibility to periodontitis. Genetic testing may be performed to assess this risk.
   - **Biopsy:** In rare cases, a small sample of gum tissue may be taken for laboratory analysis to rule out other conditions or confirm a diagnosis of periodontitis.

The severity of periodontitis is typically classified based on the depth of the gum pockets, the amount of bone loss, and the presence of other risk factors or complications. This classification helps determine the most appropriate course of treatment and the potential need for surgical interventions [29, 30, 31, 32, 33, 34]. It's important to note that early diagnosis and treatment of periodontitis are crucial, as the condition can progress rapidly and lead to tooth loss and other systemic health issues if left untreated.

6. Nonsurgical Treatments

TNonsurgical treatments are often the first line of defense against periodontitis, aimed at controlling the infection, reducing inflammation, and halting further progression of the disease. These treatments focus on removing plaque, tartar, and bacterial deposits from the affected areas [35, 36]. The primary nonsurgical treatments include (Fig. 4):

1. **Professional Dental Cleaning (Scaling and Root Planing):**
   - Scaling involves the removal of plaque and tartar from the tooth surfaces and beneath the gumline.
   - Root planing smooths the root surfaces, discouraging further buildup of plaque and tartar.
   - This deep cleaning procedure helps eliminate bacterial deposits and toxins, allowing the gums to heal and reattach to the teeth.
2. **Antimicrobial Therapy:**
   - Adjunctive antimicrobial agents, such as antiseptic mouthwashes or locally delivered antimicrobial agents (e.g., chlorhexidine, doxycycline), may be prescribed to reduce the bacterial load in the mouth.
   - These agents can be applied directly into the periodontal pockets or used as mouthwashes or gels.

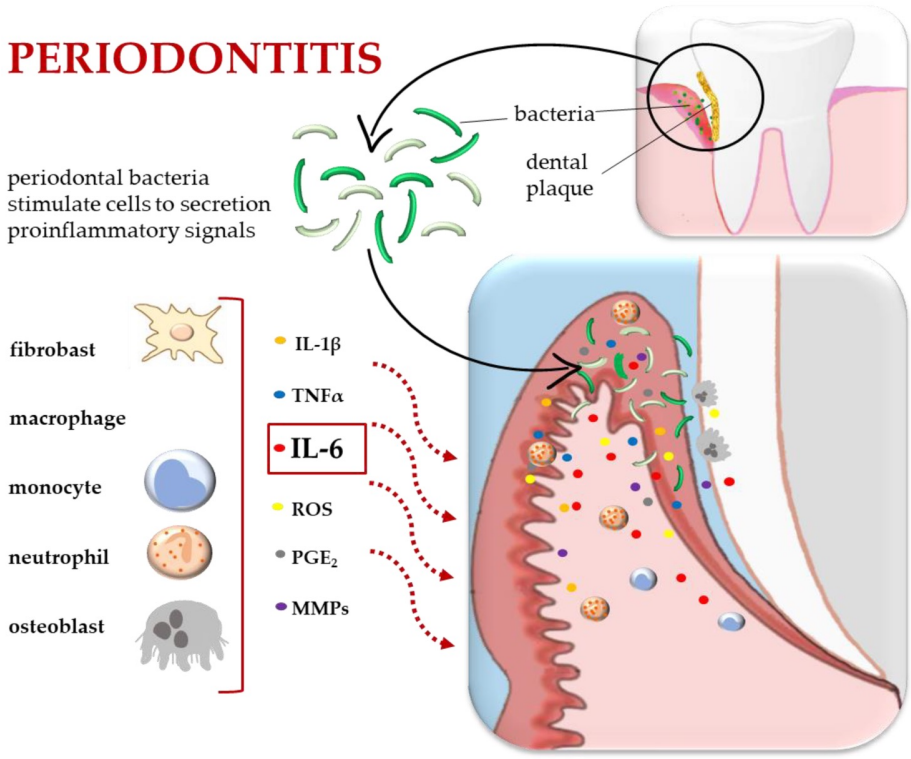

Figure 4. Inflammatory process in periodontitis.

3. **Oral Hygiene Instruction and Reinforcement:**
   - Proper brushing and flossing techniques are crucial for controlling plaque build up and preventing further progression of periodontitis.
   - Dental professionals provide personalized instruction and guidance on effective oral hygiene practices, tailored to the individual's needs and condition..

In some cases, nonsurgical treatments may be combined with adjunctive therapies, such as:

- **Systemic Antibiotics:** Prescribed for severe or acute cases of periodontitis, antibiotics help eliminate the bacterial infection and reduce inflammation.
- **Host Modulation Therapy:** This approach aims to modulate the body's inflammatory response to the bacterial infection, potentially slowing the progression of periodontitis.

Nonsurgical treatments are typically recommended as the initial approach for managing periodontitis, as they are less invasive and can effectively control the disease in its early stages. However, if these treatments are insufficient or if the condition has progressed to an advanced stage, surgical interventions may be necessary [37, 38, 39, 40].

7. Surgical Treatments

When non-surgical treatments are insufficient to control periodontitis or the condition has progressed to an advanced stage, surgical interventions may become necessary. These procedures aim to eliminate bacterial deposits, reduce pocket depths, and regenerate lost bone and tissue. Common

surgical treatments for periodontitis include:

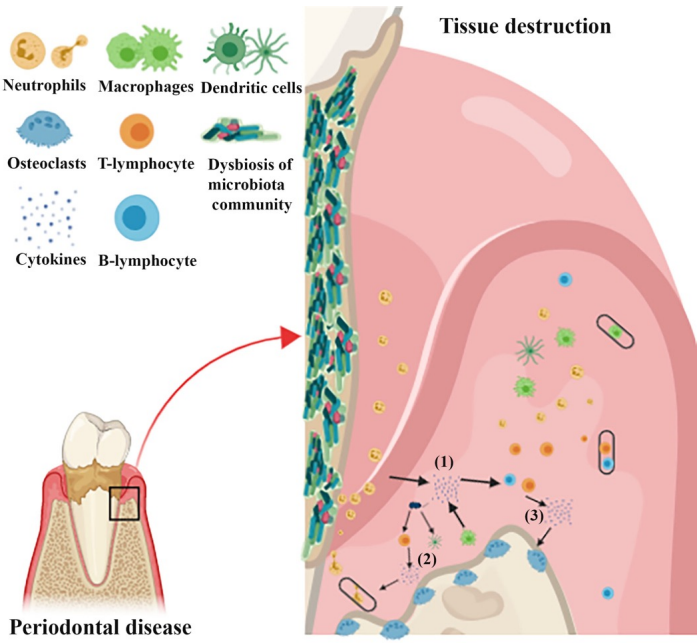

Figure 5. The 8086 die, showing the 8-bit instruction register.

1. **Flap Surgery (Pocket Reduction Surgery)**
   - The gums are folded back to expose the tooth roots and underlying bone
   - Plaque, tartar, and infected tissue are removed through scaling and root planing
   - The bone may be reshaped to create a more favorable environment for healing
   - The gums are then sutured back into place, tightly against the teeth
2. **Soft Tissue Grafts**
   - Gum tissue is grafted from the patient's palate or a donor source
   - Used to reinforce damaged gum tissue and cover exposed tooth roots
   - Improves aesthetics and reduces tooth sensitivity caused by gum recession
3. **Bone Grafting**
   - Replaces bone lost due to periodontitis with the patient's own bone or arti- ficial/donated bone material
   - Promotes bone regeneration and provides a foundation for tooth stability
4. **Guided Tissue Regeneration**
   - A specialized membrane is placed between the bone and gum tissue
   - This barrier prevents unwanted tissue from invading the area
   - Allows the body to regen- erate lost bone and connective tissue
5. **Tissue-Stimulating Proteins**
   - Gel or solution containing proteins is applied to the tooth root
   - Stimulates the growth of new bone and tissue around the tooth

Other surgical procedures may include:

- **Periodontal Pocket Procedures:** Removal of disease-causing bacteria from deep pockets and smoothing of irregular bone surfaces
- **Gingivectomy:** Removal of excessive gingival tissue without an underlying bone defect
- **Gingival Flap Procedures:** Accessing root surfaces for debridement with minimal tissue reflection
- **Osseous Surgery:** Reshaping the alveolar bone to create a favorable bone architecture
- **Crown Lengthening:** Exposing more tooth structure for restorative or cosmetic purposes
- **Gingival Grafts and Flaps:** Correcting mucogingival defects and gingival recession

The choice of surgical procedure depends on the severity and morphology of the bone defects, as well as the patient's overall oral health and risk factors. Contraindications for periodontal surgery may include a hopeless dentition, smoking, uncontrolled diabetes, and certain medications. Potential complications include bleeding, pain, swelling, infection, tooth sensitivity, and aesthetic issues [41, 42, 43, 44].

8. Prevention

Preventing periodontitis involves a combination of good oral hygiene practices, lifestyle modifications, and regular dental check-ups. Here are some effective strategies to help reduce the risk of developing this condition (Fig. 5):

1. **Maintain Proper Oral Hygiene:**
   - Brush your teeth twice daily with a soft-bristled toothbrush and fluoride toothpaste. Proper brushing technique is crucial to remove plaque effectively.
   - Floss regularly or use interdental cleaners to remove plaque and food debris from areas your toothbrush can't reach.
   - Consider using an antimicrobial mouthwash to help reduce bacteria in your mouth.
2. **Visit Your Dentist Regularly:**
   - Schedule regular dental check-ups and professional cleanings, typically every six months or as recommended by your dentist.
   - During these visits, your dentist can detect and treat early signs of gum disease, preventing it from progressing to periodontitis.
   - Comprehensive periodontal evaluations, including pocket depth measurements, can help identify and address any issues early on.
3. **Adopt a Healthy Lifestyle:**
   - Quit smoking and using other tobacco products, as smoking is a major risk factor for periodontitis.
   - Eat a balanced diet rich in vitamins and minerals, such as vitamin C, which can support gum health.
   - Manage stress levels, as chronic stress can weaken the immune system and increase the risk of gum disease..
4. **Understand Your Risk Factors:**
   - Be aware of your personal risk factors for periodontitis, such as age, genetics, and underlying medical conditions like diabetes.

- Discuss these risk factors with your dental professional and follow their recommendations for preventive care.

5. **Early Intervention:**
   - If you notice any signs of gum disease, such as bleeding gums, persistent bad breath, or gum recession, seek prompt treatment.
   - Early intervention can prevent the progression of gingivitis to periodontitis and protect your teeth and gums.

By incorporating these preventive measures into your daily routine and maintaining regular dental check-ups, you can significantly reduce your risk of developing periodontitis and maintain optimal oral health [45].

9. Complications

Untreated periodontitis can have severe consequences, leading to tooth loss and potentially impacting overall health by increasing the risk of various systemic conditions. Here are some notable complications associated with this gum disease:

1. **Tooth Loss:** As the gum infection weakens the supportive tissues holding teeth in place, the gums pull away from the teeth, creating space for harmful bacteria to multiply. This can lead to bone damage and eventually cause teeth to become loose and fall out.
2. **Systemic Health Complications:**
   - **Cardiovascular Disease:** Bacteria from the gum infection can enter the bloods tream and contribute to the development of coronary artery disease, increasing the risk of heart attacks and strokes.
   - **Respiratory Diseases:** The bacteria present in the mouth can be aspirated into the lungs, potentially leading to respiratory infections like bronchitis or pneumonia, or exacerbating existing conditions like COPD or asthma.
   - **Diabetes Complications:** People with diabetes are more susceptible to gum disease, and the combination can be dangerous. Bacteria from infected gums can leak into the bloodstream, leading to higher blood sugar levels and potential complications.
   - **Rheumatoid Arthritis:** The ongoing inflammatory response triggered by periodontitis may increase the risk of developing rheumatoid arthritis, an autoimmune disorder affecting the joints.
3. **Pregnancy Complications:** Gum disease has been associated with an increased risk of preterm birth and low birth weight, although the direct causal link is not yet clear.
4. **Cancer Risk:** Individuals with advanced gum disease may have a higher risk of developing certain types of cancer, such as lung cancer, although more research is needed to establish a definitive connection.
5. **Strain on the Immune System:** Periodontitis can lead to an ongoing inflammatory response, putting a strain on the immune system and potentially causing other health problems.

It is crucial to seek prompt treatment for gum disease to prevent these complications and maintain overall health and well-being [46, 47].

10. Outlook

The outlook for individuals with periodontitis can vary significantly based on several factors, including the severity of the disease, the presence of risk factors, and the individual's compliance with treatment and maintenance care.

1. **Prognostic Factors**
   - Periodontal disease is more prevalent among certain demographic groups, including men, individuals living below the poverty line, those with less than a high school education, and current smokers [7].
   - Several risk indicators have been identified that can influence the prognosis and potential for tooth loss, such as smoking, genetic/host susceptibility factors, older age, male gender, furcation involvement (where the tooth root divides), residual deep pockets after treatment, and non-compliance with maintenance care.
2. **Accuracy of Prognostic Systems**
   - Studies have shown that teeth with a "good" prognosis tend to remain stable over time, while those with a "fair" or "poor" prognosis often improve. Teeth with a "questionable" prognosis generally improve, but a significant number are still lost, and teeth with a "hopeless" prognosis are typically lost.
   - Prognosis is more accurate for single-rooted teeth compared to multi-rooted teeth, and third molars and mandibular molars tend to perform worse than expected.
   - Simplified prognostic models with high predictability are needed to increase clinicians' confidence in assigning tooth prognosis.
3. **Factors Influencing Prognosis**
   - The overall or global prognosis is determined based on the patient's specific risk factors, including age, systemic health, smoking status, type of periodontal disease, oral conditions, and the patient's attitude and cooperation.
   - Factors considered for individual tooth prognosis include pocket depth, attachment loss, mobility, furcation involvement, tooth morphology, bone levels, and the ability to modify etiologic factors.
   - Persistent deep pockets, mobility, and advanced furcation involvement are associated with a less favorable prognosis for individual teeth.
4. **Predictive Ability of Prognostic Systems**
   - While all four periodontal prognostic systems evaluated in a study showed good reproducibility, they had low sensitivity and positive predictive value for identifying teeth that would be lost during a 5-year supportive periodontal care period.
   - Merging some prognostic categories (e.g., "fair" and "poor") may improve the predictive ability of the prognostic systems, and the use of a 4-category system ("good," "fair," "questionable," "unfavorable/hopeless") was recommended as it provided better predictability.

It is important to note that the prognosis for periodontitis can be improved with early intervention, effective treatment, and consistent maintenance care. Regular follow-up visits and adherence to recommended oral hygiene practices can help manage the condition and prevent further progression or complications.

11. Conclusion

Periodontitis is a critical oral health condition characterized by the inflammation and destruction of the supporting structures of the teeth. Its primary cause, plaque buildup, leads to severe complications if left untreated, including gum recession, bone loss, and ultimately, tooth loss. The symptoms, such as swollen and bleeding gums, persistent bad breath, and loose teeth, are indicative of the disease's progression and highlight the need for prompt and effective intervention. Effective management of periodontitis requires a multifaceted approach. Initial treatment focuses on thorough cleaning procedures like scaling and root planning to eliminate plaque and tartar. Antibacterial

therapies may be used to control infection. For advanced cases, surgical options such as flap surgery and grafting are necessary to repair and regenerate damaged tissues and bone. Preventive measures play a crucial role in combating periodontitis. Maintaining rigorous oral hygiene practices, including regular brushing, flossing, and professional dental cleanings, is essential. Lifestyle changes, particularly quitting smoking, can significantly reduce the risk of developing or exacerbating the condition. Regular dental check-ups enable early detection and timely intervention, preventing the disease from reaching advanced stages. In conclusion, understanding the causes, recognizing the symptoms, and adhering to recommended treatment steps are vital for effectively managing periodontitis. Through proactive care and early intervention, individuals can preserve their oral health and prevent the serious consequences associated with this debilitating disease.

References

[1] Walter J Loesche and Natalie S Grossman. "Periodontal disease as a specific, albeit chronic, infection: diagnosis and treatment". In: *Clinical microbiology reviews* 14.4 (2001), pp. 727–752.

[2] Fábio Sá Carneiro Sczepanik, Márcio Lima Grossi, Márcio Casati, Michael Goldberg, Michael Glogauer, Noah Fine, and Howard C Tenenbaum. "Periodontitis is an inflammatory disease of oxidative stress: We should treat it that way". In: *Periodontology 2000* 84.1 (2020), pp. 45–68.

[3] Andrew Dentino, Seokwoo Lee, Jason Mailhot, and Arthur F Hefti. "Principles of periodontology". In: *Periodontology 2000* 61.1 (2013), pp. 16–53.

[4] Friedrich Stephanie and Louisa Karl. "Incorporating Renewable Energy Systems for a New Era of Grid Stability". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 1.1 (2020), pp. 37–49.

[5] Brook A Niemiec. "Periodontal disease". In: *Topics in companion animal medicine* 23.2 (2008), pp. 72–80.

[6] Filippo Graziani, Dimitra Karapetsa, Bettina Alonso, and David Herrera. "Nonsurgical and surgical treatment of periodontitis: how many options for one disease?" In: *Periodontology 2000* 75.1 (2017), pp. 152–188.

[7] Luciana M Shaddox and Clay B Walker. "Treating chronic periodontitis: current status, challenges, and future directions". In: *Clinical, cosmetic and investigational dentistry* (2010), pp. 79–91.

[8] Nakamura Shuto, Akari Chiyo, Himari Ken, and Sato Tanaka. "Quantum Materials to the Pioneering Future of Computing and Communication". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 1.1 (2020), pp. 50–62.

[9] Dag Orstavik. *Essential endodontology: prevention and treatment of apical periodontitis*. John Wiley & Sons, 2020.

[10] Paul V Abbott. "Classification, diagnosis and clinical manifestations of apical periodontitis". In: *Endodontic topics* 8.1 (2004), pp. 36–54.

[11] Jørgen Slots. "Periodontitis: facts, fallacies and the future". In: *Periodontology 2000* 75.1 (2017), pp. 7–23.

[12] TaeHyun Kwon, Ira B Lamster, and Liran Levin. "Current concepts in the management of periodontitis". In: *International dental journal* 71.6 (2021), pp. 462–476.

[13] Alexandre Gabriel, Claude Charles, Louis Andre, and Charlotte Antoine. "Navigating the Future of Wearable Devices with Flexible Electronics". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 1.2 (2020), pp. 63–72.

[14] Gary C Armitage and Paul B Robertson. "The biology, prevention, diagnosis and treatment of periodontal diseases: scientific advances in the United States". In: *The Journal of the American Dental Association* 140 (2009), 36S–43S.

[15] Maurizio S Tonetti, Henry Greenwell, and Kenneth S Kornman. "Staging and grading of periodontitis: Framework and proposal of a new classification and case definition". In: *Journal of periodontology* 89 (2018), S159–S172.

[16] Jimeno Estanislau, Federico Hermogenes, and Bernardo Clemente. "Battery Energy Transformation and Unravelling the Thermodynamics of Energy Storage and Conversion". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 2.1 (2021), pp. 122–135.

[17] Maurizio S Tonetti, Francesco D'Aiuto, Luigi Nibali, Ann Donald, Clare Storry, Mohamed Parkar, Jean Suvan, Aroon D Hingorani, Patrick Vallance, and John Deanfield. "Treatment of periodontitis and endothelial function". In: *New England Journal of Medicine* 356.9 (2007), pp. 911–920.

[18] Ignacio Sanz, Bettina Alonso, Miguel Carasol, David Herrera, and Mariano Sanz. "Nonsurgical treatment of periodontitis". In: *Journal of Evidence Based Dental Practice* 12.3 (2012), pp. 76–86.

[19] Wim Teughels, Rutger Dhondt, Christel Dekeyser, and Marc Quirynen. "Treatment of aggressive periodontitis". In: *Periodontology 2000* 65.1 (2014), pp. 107–133.

[20] Panos N Papapanou, Mariano Sanz, Nurcan Buduneli, Thomas Dietrich, Magda Feres, Daniel H Fine, Thomas F Flemmig, Raul Garcia, William V Giannobile, Filippo Graziani, et al. "Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions". In: *Journal of periodontology* 89 (2018), S173–S182.

[21] Nilu Jain, Gaurav K Jain, Shamama Javed, Zeenat Iqbal, Sushama Talegaonkar, Farhan J Ahmad, and Roop K Khar. "Recent approaches for the treatment of periodontitis". In: *Drug discovery today* 13.21-22 (2008), pp. 932–943.

[22] Małgorzata Cognominal, Krystyna Patronymic, and Agnieszka Wańkowicz. "Evolving Field of Autonomous Mobile Robotics. Technological Advances and Applications". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 2.2 (2021), pp. 189–200.

[23] Andrew Jacob Gross, Keith Trevor Paskett, Val Joseph Cheever, and Martin S Lipsky. "Periodontitis: a global disease and the primary care provider's role". In: *Postgraduate medical journal* 93.1103 (2017), pp. 560–565.

[24] Gary C Armitage. "Periodontal diagnoses and classification of periodontal diseases". In: *Periodontology 2000* 34.1 (2004), pp. 9–21.

[25] JF Siqueira, Isabela N Rôças, D Ricucci, and Michael Hülsmann. "Causes and management of post-treatment apical periodontitis". In: *British dental journal* 216.6 (2014), pp. 305–312.

[26] Theodore Elijah, James Clarence, Benjamin Anthony, and Christopher William. "The Journey and Potential of Organ-on-a-Chip Technology". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 2.2 (2021), pp. 211–223.

[27] Eija Könönen, Mervi Gursoy, and Ulvi Kahraman Gursoy. "Periodontitis: a multifaceted disease of tooth-supporting tissues". In: *Journal of clinical medicine* 8.8 (2019), p. 1135.

[28] Joan Otomo-Corgel, Jeffery J Pucher, Michael P Rethman, and Mark A Reynolds. "State of the science: chronic periodontitis and systemic health". In: *Journal of Evidence Based Dental Practice* 12.3 (2012), pp. 20–28.

[29] Panos N Papapanou and Cristiano Susin. "Periodontitis epidemiology: is periodontitis underrecognized, over-diagnosed, or both?" In: *Periodontology 2000* 75.1 (2017), pp. 45–51.

[30] Sarah Afiq, Maryam Fikri, Rahman Ethan, and Amsyar Isfahann. "Acknowledging the Role of Buck Converter in DC-DC Conversion". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 3.1 (2022), pp. 287–301.

[31] Angelo Mariotti and Arthur F Hefti. "Defining periodontal health". In: *BMC oral health* 15 (2015), pp. 1–18.

[32] Kenneth S Kornman. "Mapping the pathogenesis of periodontitis: a new look". In: *Journal of periodontology* 79 (2008), pp. 1560–1568.

[33] Colin E Harvey. "Management of periodontal disease: understanding the options". In: *Veterinary Clinics: Small Animal Practice* 35.4 (2005), pp. 819–836.

[34] Chung Yip, Lokyi Seol, and Xu Zhu Hon. "A Step-by-Step Approach to Partial Differential Equations". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 3.1 (2022), pp. 302–315.

[35] Dag Ørstavik. "Apical periodontitis: microbial infection and host responses". In: *Essential endodontology: prevention and treatment of apical periodontitis* (2019), pp. 1–10.

[36] Denis F Kinane, Panagiota G Stathopoulou, and Panos N Papapanou. "Periodontal diseases". In: *Nature reviews Disease primers* 3.1 (2017), pp. 1–14.

[37] J Highfield. "Diagnosis and classification of periodontal disease". In: *Australian dental journal* 54 (2009), S11–S26.

[38] Mariano Sanz et al. "Treatment of stage I–III periodontitis—The EFP S3 level clinical practice guideline". In: *Journal of clinical periodontology* 47 (2020), pp. 4–60.

[39] PNR Nair. "On the causes of persistent apical periodontitis: a review". In: *International endodontic journal* 39.4 (2006), pp. 249–281.

[40] Guilherme Marques, Francisco Gonçalves, Marco Gomes, and Beatriz Pereira. "Observations Biomedicals in Veterinary Pathobiology". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 3.2 (2022), pp. 316–328.

[41] MF Timmerman and GA Van der Weijden. "Risk factors for periodontitis". In: *International journal of dental hygiene* 4.1 (2006), pp. 2–7.

[42] David E Deas and Brian L Mealey. "Response of chronic and aggressive periodontitis to treatment." In: *Periodontology 2000* 53.1 (2010).

[43] Martha E Nunn. "Understanding the etiology of periodontitis: an overview of periodontal risk factors". In: *Periodontology 2000* 32.1 (2003), pp. 11–23.

[44] Fernanda Hernández, Leonardo Sánchez, Gabriela González, and Andrés Ramírez. "Revolutionizing CMOS VLSI with Innovative Memory Design Techniques". In: *Fusion of Multidisciplinary Research, An International Journal (FMR)* 3.2 (2022), pp. 366–379.

[45] Philip M Preshaw, Robin A Seymour, and Peter A Heasman. "Current concepts in periodontal pathogenesis". In: *Dental update* 31.10 (2004), pp. 570–578.

[46] B Sigusch, M Beier, G Klinger, W Pfister, and E Glockmann. "A 2-step non-surgical procedure and systemic antibiotics in the treatment of rapidly progressive periodontitis". In: *Journal of periodontology* 72.3 (2001), pp. 275–283.

[47] Denis F Kinane. "Causation and pathogenesis of periodontal disease". In: *Periodontology 2000* 25.1 (2001), pp. 8–20.