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Review on Periodontitis: Pathophysiology and Treatment Alternatives

Srushti A. Darade[1*]; Lokesh R. Patil[2]; Sakshi H. Mahajan[3]; Sonali R. Patil[4]; M. R. N. Shaikh[5]

[1,2,3,4,5]Department of Pharmacy, MET's Institute of D Pharmacy, Nashik, Maharashtra, India

Corresponding Author: Srushti A. Darade[1*]

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Abstract: Periodontitis is a chronic inflammatory disease that affects the supporting structures of the teeth, including the gums and bone. It begins as gingivitis and can progress to severe tissue destruction if untreated. This report reviews the causes, progression, and risk factors for periodontitis, including bacterial infection, immune response, and lifestyle habits such as oral hygiene and smoking. Current treatment methods range from mechanical cleaning and scaling to advanced surgical options, supported by new technologies like laser therapy and artificial intelligence for diagnosis. Alternative therapies using herbal medicines and minimally invasive techniques are also discussed. The report aims to provide a comprehensive overview of periodontitis for better understanding and improved treatment outcomes.

Keywords: *Periodontitis, Antimicrobial, Herbal, Dentistry, Biofilm.*

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I. INTRODUCTION

Oral health can be defined as being multidimensional in nature including physical, psychological, emotional and social domains that are integral to overall health and wellbeing. Good oral health facilitates essential human functions such as mastication (eating), Phonation (speaking), Social Interaction (smiling, socializing) free from discomfort and pain. Good oral health reflects an individual's ability to adapt to physiological changes throughout life and to maintain their own teeth and mouth through independent self-care.[1] [2]A wide range of diseases and disorders, which affects the soft and hard tissues of mouth, including an array of craniofacial disorders, congenital anomalies, injuries, and various infections. Dental diseases are Chronic and Progressive in nature. Oral diseases are a neglected issue, rarely seen as a priority in health policy. [1] [2].

➢ *Dental Caries:*

Dental caries is a localized, dynamic pathological process involving the destruction of dental hard tissues (enamel and dentine). [1] The process is initiated by acidic by-products resulting from the bacterial fermentation of free sugars (mono- and disaccharides, including those added or naturally present in honey, syrups, and juices) within the dental plaque biofilm. [3]

➢ *Periodontal Diseases:*

Periodontal diseases are chronic inflammatory conditions of the periodontium (the tissues supporting the teeth). [1] They typically begin as gingivitis, a reversible inflammation of the gingival soft tissues characterized by erythema, edema, and bleeding on probing. [4]In susceptible individuals, gingivitis can progress to periodontitis, a destructive process involving the progressive loss of periodontal tissue support. It includes Clinical attachment loss (CAL), Periodontal pocket formation, Gingival bleeding, Alveolar bone loss, which is identifiable radiographically. The primary etiological factor is the accumulation of pathogenic microbial biofilm (plaque) at and apical to the gingival margin, driven by poor oral hygiene. Tobacco use is also a significant independent risk factor. [5] [6]

➢ *Gingivitis:*

Periodontal disease is generally a progression of dental condition named Gingivitis. It is early, mild and reversible stage characterized by red, swollen and bleeding gums. Gingivitis is caused by substances derived from microbial plaque accumulating at or near the gingival sulcus; all other suspected local and systemic etiologic factors either enhance plaque accumulation or retention or enhance the susceptibility of gingival tissue to microbial attack. [7] Microbial species specifically associated with gingival health includes *Streptococcus sanguia* 1, S. D-7, and *Fusobacterium*

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naviforme. If gingivitis is untreated it leads to the severe condition known as Periodontitis. [7]

➢ *Periodontitis:*

The advance, severe, and irreversible stage of gingivitis where the inflammation causes the bone and tissue holding the teeth in place to break down, resulting in gum recession, loose teeth, and ultimately, tooth loss. Periodontitis is a chronic multifactorial inflammatory disease associated with the accumulation of dental plaque (which can be referred to as dental biofilm/ biofilm), and characterized by progressive destruction of the teeth-supporting structure, including the periodontal ligament and alveolar bone. [8, 9, 10]The disease involves complex dynamic interactions among specific bacterial pathogens. The common risk of periodontitis includes gingival inflammation, clinical attachment loss, radiographic evidence of alveolar bone loss, sites with deep probing depths, mobility, bleeding upon probing and pathologic migration. [9, 10] Periodontal disease is a common chronic infection caused by gram-negative bacteria such as *Porphyromonas. gingivalis*, *Actinobacillus actinomycetemcomitans*, and *Tannerella* synthesis that colonize the subgingival biofilms. [12]

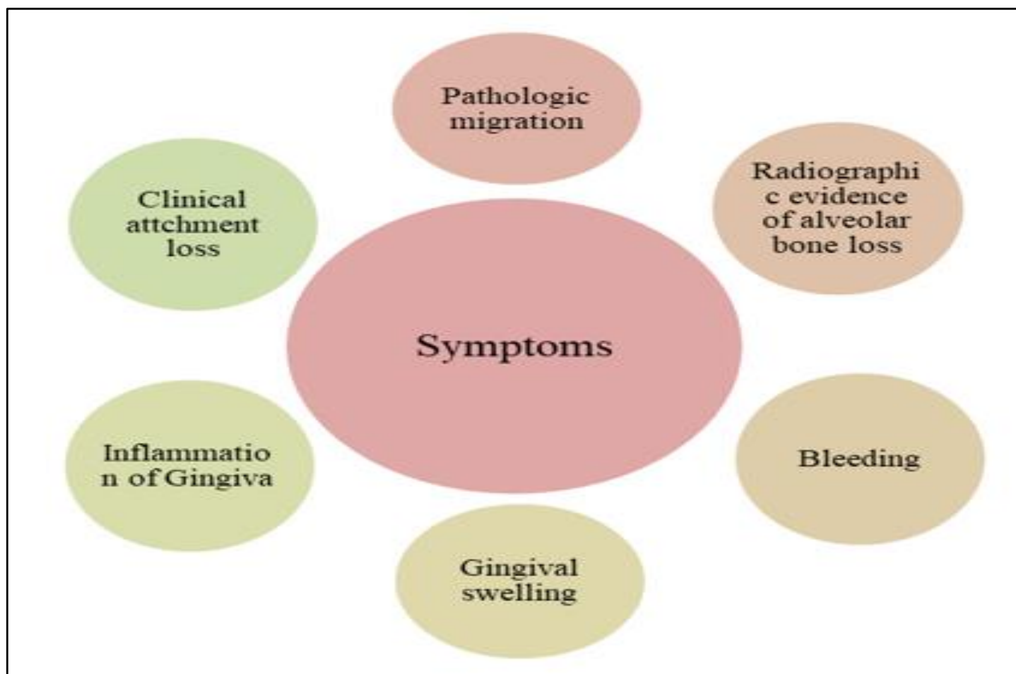

Fig 1 Symptoms of Periodontitis [12, 13]

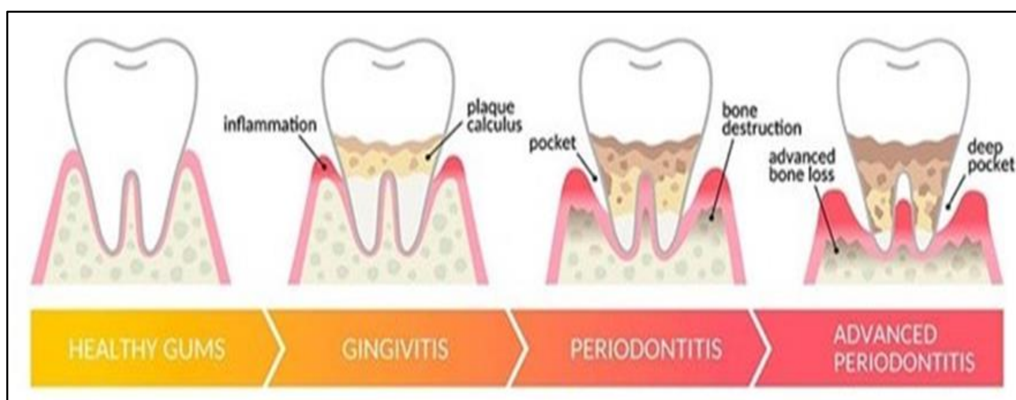

Fig 2 Stages of Periodontitis

➢ *Periodontal Diseases Can be Categories in Number of Class, Few of the as Listed Below: [14]*

- *Simple Periodontitis:*

Chronic inflammation of the gingiva caused by "local irritation" (i. e., plaque and calculus) and associated with horizontal bone loss.

- *Compound Periodontitis:*

Periodontitis with angular bone destruction due to "local irritation" plus "occlusal disharmony".

- *Periodontosis:*

A non-inflammatory degeneration of the supporting periodontal tissues which may be aggravated by occlusal trauma and inflammatory changes.

- *Occlusal Periodontitis (Trauma from Occlusion):* Degenerative and necrotic changes in the support.

➢ *Pathogenesis of Periodontitis:*

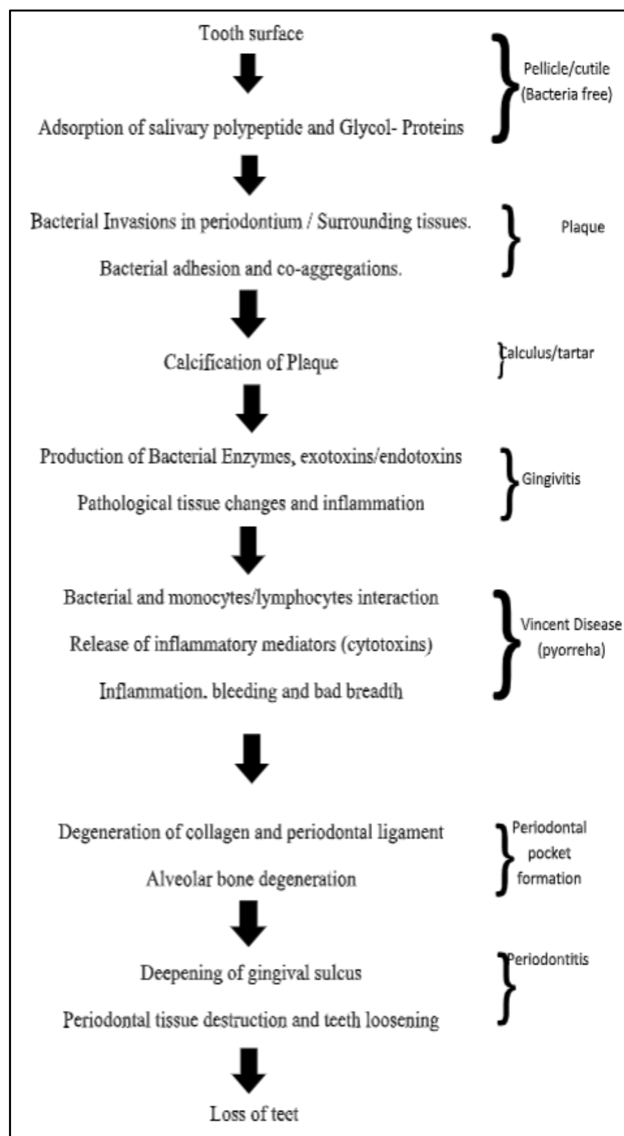

Fig 3 Pathogenesis of Periodontitis [15]

II. THERAPEUTIC INTERVENTIONS

➢ *Initial Phase and Patient Compliance:*

Treatment of aggressive periodontitis starts with patient education and ensuring patient compliance. A considerable amount of time should be invested in establishing a good patient–clinician relationship. The time devoted to this, before commencing any form of active treatment and during the whole process of periodontal therapy, will have an impact on treatment success that should not be underestimated. [16] The patient should be clearly informed about the dis ease process, contributing factors, the different phases and goals of the treatment, the predictability of treatment success and the patient's own crucial role in the treatment. The patient should be aware that, for success, it is essential for optimal compliance in plaque control and maintenance and for possible modifiable risk factors to be addressed. If the clinician doubts the compliance of the patient, several pre-treatment visits could be included in the treatment plan, in which compliance with oral-hygiene instructions can be monitored and enhanced, together with compliance towards, for example, a smoking-cessation protocol. [16]

➢ *Patient Self-Care and Biofilm Management:*

Patient self-care seeks to remove dental biofilms in order to maintain periodontal health and reduce the need for professional intervention. However, current methods of biofilm removal are cumbersome, largely ineffective and have essentially remained unchanged for the past 50 years. [17] Despite yielding better statistical outcome than placebo controls, the absolute effectiveness of oral hygiene products is not satisfactory. [18] Oral hygiene studies also tend to have a duration of 12 months or less, and whether common self-care products actually save teeth long term is unknown. Another concern is that self-care products are typically tested in individuals with gingivitis or mild periodontitis, diseases that are most likely to respond favorably but are not representative of most adult types of periodontal disease. [8]

➢ *Scaling and Root Planning (SRP):*

After appropriate home care or biofilm management has been completed, scaling and root planning should be performed on the areas with periodontal probing depths of 5 mm or higher. Concurrent with this phase of treatment, active carious lesions should be treated, teeth beyond repair should be extracted, and local contributing factors should be corrected. Before starting scaling and root planning, enough local anesthetic should be administered to ensure patient comfort. [19] Automated and manual tools, such as piezoelectric or ultrasonic scalers, can be combined. In areas with difficult access, curettes might not be as efficient as automated tools for eliminating calculus and subgingival biofilm. [12]

➢ *Periodontal Surgical Therapies*

- *Resective Periodontal Surgery:*

Consistently deep probing depths are often linked to infrabony or vertical osseous defects, which significantly lower tooth survival rates. Osseous restorative surgery (involving osteotomy and osteoplasty) aims to reduce or eliminate these defects, followed by apical positioning of the gingival tissue to the new alveolar crest height. This procedure resolves or reduces deep probing depths. Soft tissue excision may be an option for persistently deep probing depths without an underlying alveolar defect. [12, 20, 21]

- *Periodontal Regenerative Surgery:*

This surgery aims to restore periodontium destroyed by disease, specifically increasing clinical attachment, promoting bone growth, and strengthening the dentition. It is considered for infrabony or vertical abnormalities. Techniques like Guided Tissue Regeneration (GTR) utilize a barrier membrane containing bone graft material. Recent approaches integrate biologic modifiers with barrier membranes and bone grafts to enhance regenerative outcomes. [12, 22, 23]

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- *Mucogingival Surgery:*

Mucogingival deformities should be thoroughly assessed and repaired, if indicated, after initial periodontal therapy. Assessment parameters include gingival recession extent and progression, width of keratinized gingiva, frenal involvement, vestibular depth, marginal inflammation, dentinal hypersensitivity, and aesthetic concerns. [12]

➢ *Nonsurgical Treatment and Systemic Antibiotic*

- *Nonsurgical Treatment:*

The effect of nonsurgical treatment alone on aggressive periodontitis is considerably less established than its effect on chronic periodontitis. A key factor is the extent and predictability of clinical changes such as reduction in probing pocket depth, gain in clinical attachment, and decrease in bleeding on probing achievable by SRP alone. [16]

- *Systemic Antibiotics:*

The combination of amoxicillin and metronidazole has become a widely used adjuvant for treating generalized aggressive periodontitis. This protocol emerged after tetracycline proved ineffective against *A. actinomycetemcomitans.* In vitro data showed a synergistic effect of amoxicillin and metronidazole against this key pathogen. As an adjunct to SRP, the regimen of 250 mg metronidazole and 375 mg amoxicillin, three times a day for seven days, has proven highly efficient in eradicating subgingival *A. actinomycetemcomitans* [24]and demonstrates both clinical and microbiological efficacy in treating persistent periodontitis. [16]

- *Tetracyclines Are Used Despite Tooth Discoloration in treatment of periodontitis!*

Tetracyclines are still used in the treatment of periodontitis despite the risk of tooth discoloration particularly among children because their clinical effectiveness and unique therapeutic benefits far outweigh this side effect in adult populations and specific patient scenarios. [25, 26]

- *Tetracycline is used for the Following Actions/Effects:*

✓ *Potent Antibacterial Action:*

Tetracyclines are effective against a broad spectrum of periodontal pathogens, reducing both gram-positive and gram-negative bacteria that contribute to disease. [25]

✓ *High Gingival Fluid Concentrations:*

Tetracyclines reach higher concentrations in gingival fluid than in blood (2–4 times more), directly targeting the site of infection. [25]

✓ *Non-Antimicrobial Benefits:*

They provide important benefits beyond antimicrobial action, including inhibition of matrix metalloproteinases (MMPs) enzymes that break down connective tissue thereby reducing tissue destruction. [26, 27, 28]

✓ *Anti-Inflammatory and Wound-Healing Effects:*

Tetracyclines have proven anti-inflammatory and wound-healing properties that help stabilize attachment levels and minimize bone loss, enhancing periodontal health beyond what is achieved with standard scaling and root planning alone. [26, 28]

✓ *Reduce Discoloration Risks:*

▪ *Patient Selection:*

Tooth discoloration is primarily a concern when tetracyclines are given during tooth development (roughly up to age 8), so use is largely restricted to adults with fully formed teeth, where the risk is minimal. [29]

▪ *Localized Application:*

Many periodontal therapies use local or controlled-release formulations (e.g., antibiotic fibers or gels placed in periodontal pockets), further limiting systemic exposure and risk of tooth staining. [25, 28]

▪ *Avoidance in Vulnerable Populations:*

Children, pregnant women, and those at risk for dental development discoloration are typically not prescribed tetracyclines for this reason. [25]

▪ *Clinical Impact:*

The clinical improvements including greater reductions in pocket depth, increased attachment levels, decreased inflammation, and enhanced long-term periodontal stabilization often justify tetracycline's adjunctive use in moderate to severe and refractory periodontitis, especially in cases where other antibiotics are less effective or unavailable. [25, 28, 30]

➢ *Drawbacks of Periodontitis Treatments*

Periodontitis treatments, while effective in managing gum disease, are associated with several notable drawbacks that can impact patient outcomes, comfort, and long-term oral health.

In everyday terms, while tetracycline can help control gum infections, over time the bacteria can adapt and stop responding to the medication. This makes it harder to treat gum disease and increases the risk that these stronger germs could cause other health problems or spread resistance to other people. [28]

Common Drawbacks are listed below**:** [31, 32]

- Pain, swelling, and bleeding after nonsurgical therapies
- Dentine sensitivity post-treatment for several weeks
- Risk of procedural errors causing damage to teeth or restorations
- Reduced effectiveness in smokers and patients with systemic conditions

While the major effects are also faced such as gastrointestinal disturbance and, rarely, allergic reactions. Tetracycline should be avoided in children and pregnant women due to risks of teeth discoloration and effects on bone growth. Compliance is critical; missed doses or incomplete courses further accelerate resistance and lower the medication's effectiveness against periodontitis. [33]

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III. LITERATURE REVIEW

Table 1 Literature Review

Title	Author	Work	Conclusion
Diabetes-A Risk Factor for Periodontitis in Adults? [34]	Richard C. Oliver and Tellervo Tervonen	Examining the relationship between diabetes and periodontitis and its mechanisms.	Periodontitis is linked to poorly-controlled diabetes, which may be a risk factor for periodontal disease severity and progression.
A study of the bacteria associated with advancing periodontitis [35]	A. B. C. Tanner, C. Haffajee, G. T. Bratthal, R. A. Visconti, and S. S. Socransky	Studying the subgingival microflora associated with active, advancing destructive periodontitis.	Predominant destructive microflora included *Bacteroides asaccharolyticus*, *B. intermedius*, *B. melaninogenicus*, *Eikenella corrodens*, *Actinobacillus actinomycetemcomitans*, and certain *Vibrio* species.
Systemic antibiotics in the treatment of periodontitis [36]	Magda Feres, Luciene C. Figueiredo, Geisla M. Silva Soares, and Marcelo Faveri	Overview of the role and rationale for using systemic antibiotics as an adjunct in periodontitis treatment.	Understanding the etiology and microbiological basis of periodontitis is fundamental for the successful use of systemic antibiotics as part of treatment.
Systemic Markers of Inflammation in Periodontitis [37]	Bruno G. Loos	Reviewing current knowledge on systemic levels of inflammation, focusing on inflammatory markers (e.g., CRP, fibrinogen) in periodontitis.	Periodontitis is associated with elevated systemic inflammation, and the disease may have an impact on systemic health, including cardiovascular risk.
Clinical Criteria for the Definition of "Established Periodontitis" [38]	Eli E. Machtei, Lars A. Christersson, Sara G. Grossi, Robert Dunford, Joseph E. Zambon, and Robert J. Genco	Defining clinical criteria for established periodontitis based on objective periodontal parameters.	The defined clinical entity of "established periodontitis" (e.g., CAL 3 mm and PPD 5 mm at one or more sites) is useful for defining a subset of the population with severe disease.
Nonsurgical treatment of periodontitis [39]	Ignacio Sanz, Bettina Alonso, Miguel Carasol, David Herrera, and Mariano Sanz	Reviewing and evaluating current and future concepts and protocols for non-surgical periodontal treatment.	Scaling and root planing (SRP) remains the gold standard, but newer technologies (e.g., lasers, local delivery agents) are emerging as effective aids or alternative treatments.
Genetic and environmental risk factors for chronic periodontitis and aggressive periodontitis [40]	Ayala Stabholz, W. Aubrey Soskolne, and Lior Shapira	Reviewing genetic and environmental risk factors and their impact on the susceptibility and severity of periodontitis.	Periodontitis is a multifactorial disease where genetic polymorphisms, hereditary factors (familial aggregation), and environmental/acquired factors (e.g., smoking) all contribute to disease expression.
Recent approaches for the treatment of periodontitis [15]	Nilu Jain, Gaurav K. Jain, Shamama Javed, Zeenat Iqbal, Sushama Talegaonkar, Farhan J. Ahmad, and Roop K. Khar	A review of therapeutic strategies, focusing on recent developments like drug delivery systems for managing periodontal disease.	Periodontal disease is a localized inflammatory response, and recent advances in drug delivery systems aim to improve efficacy and compliance in therapeutic management.
Cardiovascular disease parameters in periodontitis [41]	Andréa M. Monteiro, Maria A.M. Jardini, Sarah Alves, Viviana Giampaoli, Elisete C.Q. Aubin, and Magnus Guiotoku	Investigating cardiovascular disease risk parameters (e.g., lipids, C-reactive protein) in patients with and without periodontitis.	Periodontitis patients showed significantly higher levels of triglycerides, total cholesterol, LDL, ox-LDL, and IL-6, suggesting a link between periodontitis and increased cardiovascular risk factors.
Periodontal treatment improves endothelial dysfunction in patients with severe periodontitis [42]	S. Seinost, R. Gasser, D. Mittermayer, R. Bräunlich, D. Genser, G. Steindl, and W. G. Gfrerer	Studying the effect of non-surgical periodontal treatment on endothelial function in severe periodontitis patients.	Periodontal treatment significantly improved flow-mediated dilation (FMD) and reduced serum levels of inflammatory markers, suggesting treatment can improve endothelial dysfunction.

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State of the science: chronic periodontitis and systemic health [43]	Joan Otomo-Corgel, Jeffery J. Pusser, Michael P. Rethman, Mark A. Reynolds	Reviewing the evidence linking chronic periodontitis to major systemic conditions (e.g., cardiovascular disease, diabetes, rheumatoid arthritis).	Evidence supports an association between periodontitis and several systemic diseases, suggesting periodontitis is a source of chronic local inflammation with potential systemic effects.
Current concepts in the management of periodontitis [12]	TaeHyun Kwon, Ira B. Lamster, and Liran Levin	A concise clinical review summarizing the etiology, diagnosis, and current management strategies for periodontitis.	Periodontitis is a complex disease resulting from an interplay of microbial pathogens, susceptible hosts, and risk factors; management requires effective diagnosis and a combination of conventional and regenerative treatments.
A systematic review of definitions of periodontitis and methods that have been used to identify this disease [44]	Amir Savage, Kenneth H. Eaton, David R. Moles, and Ian Needleman	Systematically reviewing and analyzing the various clinical definitions and diagnostic methods used to identify periodontitis in studies.	There is a lack of consensus on a single definition for periodontitis, with wide variation in the diagnostic thresholds (CAL and PPD) used across different studies.
Genetic susceptibility to periodontitis [45]	Marja L. Laine, Wim Crielaard, and Bruno G. Loos	Reviewing the role of host genetics, polymorphisms, and gene-environment interactions in determining susceptibility to periodontitis.	Genetic background is a major determinant of periodontitis risk, which is considered a complex disease resulting from the interaction of polygenic factors and environmental exposures (e.g., bacteria, smoking).
The genetic basis of periodontitis [46]	Denis F. Kinane, Hideki Shiba, and Thomas C. Hart	Reviewing the evidence for a genetic basis of periodontitis, including Mendelian-based and complex traits.	Genetics play a major role in susceptibility and severity. Understanding the genetic determinants is crucial for diagnostics and targeted therapeutic approaches.
Microbial etiology of periodontitis [47]	Tatsushi Nishihara and Takeyoshi Koseki	Discussing the concept of periodontitis as a microbial disease and the characteristics of periodontopathic bacteria.	Periodontitis is a polymicrobial infection; treatment aims to eliminate or reduce target bacteria based on understanding the nature of the periodontopathic microbiota.
Periodontitis: facts, fallacies and the future [8]	Jorgen Slots	Discussing current periodontitis concepts, challenging long-held beliefs, and proposing a shift toward specific microbial/viral etiologies.	The clinical entity of periodontitis is highly complex; *Porphyromonas gingivalis* and herpesviruses may be primary agents in destructive periodontitis.
Early-Onset Periodontitis [48]	Maurizio S. Tonetti and Andrea Mombelli	Reviewing the classification and clinical/etiological characteristics of Early-Onset Periodontitis (EOP).	EOP is a distinct and heterogeneous group of diseases characterized by early onset and rapid progression, suggesting different underlying systemic and microbiological factors compared to adult periodontitis.
Treatment of aggressive periodontitis [16]	Wim Teughels, Rutger Dhondt, Christel Dekeyser, and Marc Quirynen	Reviewing the diagnosis, etiology, and general treatment concepts for aggressive periodontitis.	Aggressive periodontitis requires an aggressive treatment approach, often involving systemic antibiotics in addition to conventional periodontal therapy, and aims for maximum tooth retention.
An Exploration of the Periodontitis–Cancer Association [49]	Philippe P. Hujoel, Mark Drangsholt, Charles Spiekerman, and Noel S. Weiss	Investigating the association between periodontitis and the risk of various systemic cancers.	Periodontitis was associated with an increased risk of total cancer mortality and specifically cancers of the lung and total gastrointestinal tract.

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- *Recent Advances in Periodontitis Management (2020-2025)*

- *Laser Technology:*

The application of laser technology in periodontal therapy is among the most noteworthy developments in contemporary dentistry. This cutting-edge method greatly reduces harm to nearby healthy tissues by using the accuracy of lasers to administer targeted treatment to infected tissue. Diode lasers, for example, have been demonstrated to not only lessen bleeding during procedures but also to encourage quicker healing, which lessens the trauma patients endure overall. According to studies, diode lasers are the most widely used laser technologies because of their affordability, portability, and simplicity. [50, 51]These assertions are supported by a research that patients treated with laser therapy experience noticeably less pain and used fewer analgesics, demonstrating how well this technology works to improve patient comfort following surgery than those treated with conventional techniques. [37]

- *Photodynamic Treatment:*

Since photons, or light energy, are used by PBM lasers to modify biological processes, the word photo biomodulation (PBM) (also known as low-level laser therapy, or LLLT) defines how these lasers function. PBM activates several transcription factors, including the antimicrobial peptide h-BD-2 (human β-defensin-2). PBM and PDT have a similar mechanism of action. Still, PDT uses a combination of light- and photo-sensitive medications that target chromophores to kill bacteria or cancerous cells. In contrast, PBM promotes wound healing or relieves pain. [53, 54, 55] PBM is becoming an increasingly important part of contemporary dental care, a non-invasive therapeutic method that complements conventional dental procedures. [56, 57] More recently, PBM has been suggested as a supplement to dental hygiene therapies for periodontal diseases. The local impact of PBM on treating periodontal pockets in patients with type 2 diabetes and periodontitis was examined in a prior study. [58]The PBM protocol was more successful in lowering the proportion of moderate and severe periodontal pockets at 3, 6, and 12 months in patients with type 2 diabetes mellitus, even though it did not significantly alter PPD and CAL in periodontal pockets when compared to mechanical therapy alone. [52]

- *Biomaterials and Regenerative Therapy:*

Even with the most sophisticated tissue engineering techniques, it is still challenging to regenerate the periodontium, the location of periodontal diseases, because it is an incredibly intricate plexus of hard and soft tissues. On the other hand, nanotechnologies have made it possible to create biomaterials and pharmaceutical formulations that can significantly improve the effectiveness of conventional pharmacotherapies and surgical techniques. [59] Injectable biomaterials are typically chosen over implanted ones in the mouth cavity for regenerative purposes. The viscous formulations known as injectable biomaterials are delivered in a liquid or gel-like state. Their most notable advantage is their ability to be easily administered with a needle, a straightforward and far less intrusive process that reduces collateral damage around the injury sit e. [52]

- *CAD/CAM and 3D Bioprinting Techniques:*

The goal of additive manufacturing is to direct the in vivo development of a wholly integrated periodontium-like structure of alveolar bone, periodontal ligament, and cementum/dentin. [60] Scaffolds and tissue constructions that closely resemble the natural architecture of periodontal tissues can now be precisely fabricated thanks to advancements in 3D bioprinting. [61, 62]To achieve high-resolution and high-precision bioprinting, methods like inkjet, laser-assisted, extrusion, micro extrusion, and digital light processing have proved essential. Every technique has its benefits. For example, extrusion-based techniques enable using a broad range of materials, whereas laser-assisted printing offers excellent resolution and cell viability. [52]

- *Digital Imaging Techniques:*

CBCT has revolutionized dental diagnostics, particularly in evaluating periodontal disease. [63, 64] Compared to conventional two-dimensional radiographs, CBCT provides three-dimensional images of periodontal structures, improving the precision of assessing bone loss and the degree of periodontal disease. [52]

- *Artificial Intelligence:*

Artificial intelligence (AI) transforms periodontology by analyzing vast data to identify patterns and predict disease progression. This allows for early intervention and personalized treatment plans. [52]AI can evaluate risk factors, enhancing preventive care strategies. As technology evolves, it will lead to better outcomes for patients with periodontal diseases, improving the efficiency of practices and enhancing patient care. [65]

- *Minimally Invasive Surgical Technique:*

Developments in minimally invasive surgical techniques - like the pinhole surgical technique - have been increasingly popular in recent years. [52] This novel method entails the dentist repositioning existing gum tissue over the exposed tooth roots using a tiny, specifically made tool that makes a small pinhole in gum tissue. This procedure is desirable because it does not require donor tissue, frequently attributing their favorable experiences to speedy recovery and instantaneous cosmetic improvements. [66]

IV. CONCLUSION

Periodontitis is a severe oral disease that requires early diagnosis and effective management to prevent tooth loss and other complications. While traditional treatments remain effective, emerging technologies and new therapeutic approaches offer improved precision and patient comfort. Preventive care, patient education, and regular dental visits are essential to control the disease and maintain oral health. Continued research and development are needed to enhance treatment success and patient quality of life.

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