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Interrelationship Between Periodontal Diseases And Diabetes Mellitus: A Review Of Integrated Oral And Systemic Management For Improved Glycemic And Oral Health Outcomes

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Abstract:
The interrelationship between periodontal diseases and type 2 diabetes mellitus (T2DM) has been extensively investigated in recent years, emerging as a topic of growing relevance in public health. T2DM, a chronic disease with high global prevalence, significantly impacts oral health, particularly due to the increased susceptibility to periodontal infections. At the same time, periodontal inflammation appears to contribute to the worsening of glycemic control through systemic inflammatory mechanisms. This article reviews scientific evidence on this bidirectional relationship, focusing on the effects of non-surgical periodontal therapy on glycated hemoglobin (HbA1c) levels, suggesting potential clinical benefits of an integrated approach. Challenges and barriers to implementing interdisciplinary care are also discussed, such as the lack of communication between professionals, limited access to dental services in vulnerable populations, and behavioral factors that affect treatment adherence. Finally, the study emphasizes the importance of establishing collaborative protocols among dentists, endocrinologists, and other healthcare professionals, as well as incorporating oral health into diabetes management guidelines as a key strategy to improve patients' quality of life and prognosis. There is, therefore, an urgent need for randomized clinical trials with greater methodological rigor, as well as for public policies that integrate oral health as a core component of diabetic patient care.

Key Word: *Periodontitis, Type 2 Diabetes Mellitus, Glycemic control, Oral health, Interdisciplinary approach*.

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I. Introduction

In recent years, the relationship between oral infections and systemic disorders has become a prominent area of interest within the medical and dental scientific communities. In this context, several studies have demonstrated a strong correlation between oral infections and cardiovascular disease, low birth weight, insulin resistance (IR), and diabetes mellitus (DM) [1,2].

DM is considered by the World Health Organization (WHO) and the International Diabetes Federation a global epidemic, currently affecting 424.9 million people worldwide. In Brazil, it is estimated that approximately 8.7% of the population aged between 20 and 79 years has the disease, totaling 12.5 million individuals. Furthermore, it is projected that by 2045, the number of people with DM worldwide will exceed 629 million [3]. DM comprises a heterogeneous group of diseases and metabolic alterations, primarily characterized by chronic hyperglycemia [4].

Clinical and experimental studies have demonstrated a higher prevalence of periodontal disease and endodontic problems in patients with uncontrolled diabetes [5,6]. These effects may be associated with the hyperglycemic state characteristic of diabetes, which can lead to deleterious effects on the dental pulp, worsening

the severity of oral inflammation and alveolar bone resorption [7]. It is now well established that inflammation can exacerbate DM primarily through the release of pro-inflammatory cytokines, which may induce insulin resistance [8].

Given the close bidirectional relationship between periodontal diseases and diabetes mellitus—and considering both the impact of hyperglycemia on oral tissues and the role of inflammation in the deterioration of glycemic control—it becomes essential to understand how integrated interventions can simultaneously improve oral and systemic health. Therefore, the aim of this study is to review the scientific evidence on the association between periodontal diseases and diabetes mellitus, highlighting management strategies that integrate oral and systemic control, with an emphasis on the mutual benefits for glycemic regulation and the prevention or progression of periodontal complications.

II. Materials And Methods

This study is a bibliographic literature review based on the selection and analysis of scientific articles retrieved from multiple databases, including Google Scholar, PubMed, Scielo, LILACS, and Embase. The search strategy employed specific descriptors such as periodontal disease, diabetes mellitus, glycemic control, inflammatory mediators, and insulin resistance. Articles included in this review were full-text publications, available in open access, and written in either Portuguese or English. Each selected article was subjected to a critical evaluation of its objectives, methodology, results, and discussion. This systematic and analytical approach provided the foundation for the present literature review.

III. Results And Discussion

Periodontal Disease as an Aggravating Factor in Glycemic Control

A bidirectional relationship between periodontitis and diabetes mellitus (DM) has been well established in the literature. In other words, the systemic complications of DM contribute to changes in periodontal conditions [9,10], while glycemic homeostasis may be affected by periodontal disease (PD) [11]. Biofilm, gingivitis, and periodontitis are interrelated, as the accumulation of supragingival microbial biofilm can progress to subgingival infections and PD. In severe cases, PD may involve inflammation of both the supporting tissues (gingiva) and the anchoring structures (cementum, alveolar bone, and periodontal ligaments). In adults, the subgingival microbial environment associated with dental caries is predominantly composed of gram-negative anaerobic bacteria (e.g., Porphyromonas gingivalis, Prevotella intermedia). Without treatment, periodontal disease may result in the progressive loss of alveolar bone, leading to tooth loosening and eventual tooth loss. The pathogenic effects of PD are caused by microorganisms adhering to the tooth surfaces and by an aggressive inflammatory response against these microorganisms [12]. The etiology of periodontitis suggests that bacterial infection is the primary cause of the disease, which results from a complex interaction between pathogens and the host [13]. This interaction leads to the activation of monocytes by T lymphocytes, which triggers the production of high levels of inflammatory mediators, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) [14]. These cytokines activate osteoclasts, promoting bone resorption, and increase collagenase activity, thereby contributing to greater destruction of periodontal ligament fibers and, consequently, tissue and bone loss [15].

These locally produced inflammatory mediators may serve as a chronic source of systemic insult. As a result, the presence of PD elevates circulating levels of these markers, leading to an exacerbated inflammatory state which, in individuals with diabetes, may contribute to increased insulin and glucose resistance [16,17]. TNF-α is released into the bloodstream from ulcerated lesions in periodontal pockets [14]. Evidence suggests that TNF-α involved in gingival inflammation may act as a potent inhibitor of insulin receptors, potentially playing a role in the development of insulin resistance by affecting organs such as the liver, muscles, and adipose tissue [18]. This cytokine impairs insulin intracellular signaling by inhibiting insulin-dependent autophosphorylation of its receptor, as well as phosphorylation of insulin receptor substrate-1 (IRS-1), the primary in vivo target of the insulin receptor. Furthermore, TNF-α stimulates the release of free fatty acids, which also promote the phosphorylation of insulin receptors, thereby hindering insulin action by preventing proper phosphorylation. Interleukins 6 and 1 (IL-6 and IL-1) also play significant roles by inducing the synthesis of acute-phase proteins such as C-reactive protein and fibrinogen, which may further exacerbate insulin resistance and hinder glycemic control [18,19]. The literature indicates that increased levels of anti-inflammatory cytokines, such as adiponectin, are associated with up to a 16% reduction in the incidence of diabetes. Adiponectin is exclusively produced by adipose tissue and acts on insulin receptors, enhancing sensitivity to insulin and reducing the concentration of inflammatory mediators. Low adiponectin levels are associated with a higher predisposition to insulin resistance. Periodontal therapy, in turn, can increase circulating adiponectin levels by up to 32%, reinforcing the importance of maintaining oral health [17,20].

Effects of Periodontal Treatment on Glycemic Control

Several studies have explored the relationship between periodontal health and glycemic control in individuals with type 2 diabetes, highlighting the therapeutic potential of non-surgical periodontal treatment. In the study conducted by Pham et al. (2022), the objective was to evaluate the effects of non-surgical periodontal therapy in smokers with type 2 diabetes mellitus and periodontitis over a six-month period. Forty participants with moderate to severe periodontitis, who were smokers and had been diagnosed with type 2 diabetes, were randomly assigned to two groups: the test group, which received non-surgical periodontal treatment (including oral hygiene instructions, scaling and root planning, and the use of a 0.05% chlorhexidine mouthwash); and the control group, which received oral hygiene guidance, supragingival plaque and calculus removal, and the same mouthwash. After six months, the test group showed significant improvements in glycemic control and a reduction in pro-inflammatory markers compared to the control group, which exhibited a slight worsening of metabolic and inflammatory parameters.

Moreover, other studies reinforce the importance of non-surgical periodontal treatment as an adjuvant therapeutic strategy in the management of type 2 diabetes. The study conducted by Graziani et al. (2023) aimed to compare the effects of full-mouth versus quadrant-based non-surgical periodontal treatment, evaluating levels of inflammatory markers and endothelial function after 24 hours and 90 days in individuals with type 2 diabetes mellitus. After applying inclusion and exclusion criteria, 40 participants were selected and randomly assigned to the two treatment groups. The results demonstrated that full-mouth treatment induced a more intense acute systemic inflammatory response 24 hours after the intervention compared to the quadrant-based treatment. These acute systemic changes may counteract the metabolic benefits of periodontal therapy, such as reductions in glycated hemoglobin (HbA1c) and improvements in endothelial function. Although the primary focus of the study was not HbA1c analysis, this parameter was measured at the end of the study. A significant reduction in HbA1c was observed, particularly among individuals who received quadrant-based treatment, in whom the decrease was twice as great as in those treated with the full-mouth approach.

Additionally, Rapone et al. (2021) investigated, through a randomized clinical trial, the impact of non-surgical periodontal therapy on short-term glycemic control and systemic inflammatory status. The study followed 187 patients with type 2 diabetes for six months, with 93 patients receiving immediate periodontal treatment and 94 receiving delayed intervention. The treatment consisted of scaling and root planning sessions under local anesthesia, lasting 45 minutes per quadrant, using ultrasonic instruments. At the end of the follow-up period, glycated hemoglobin levels were measured in both groups to allow for comparative analysis. The authors concluded that non-surgical periodontal treatment can significantly contribute to better glycemic control and a reduction in C-reactive protein levels in individuals with type 2 diabetes.

The growing body of evidence supporting the benefits of non-surgical periodontal treatment in glycemic control also extends to diverse geographical and socioeconomic contexts. One example is a randomized clinical trial conducted in an urban center in sub-Saharan Africa, which aimed to investigate the effects of periodontal therapy on improving glycemic control in individuals with poorly controlled type 2 diabetes. The study included 34 patients randomly allocated to two groups: the first group (n = 17) received immediate intervention with ultrasonic scaling, followed by root planning and subgingival irrigation with 10% povidone-iodine; the second group (n = 17) had their periodontal treatment postponed for three months after study initiation.

It is important to note that all participants continued their usual pharmacological treatment and received standardized guidance on oral hygiene and diabetes management, ensuring consistency across other variables. After three months, the results showed a significant improvement in glycemic control among patients in the immediate treatment group, with an average reduction of 3.0 ± 2.4 points in HbA1c levels. In contrast, the group that had not yet received treatment showed no relevant changes in HbA1c levels. The average difference of 2.2 ± 2.5 points attributed to the periodontal intervention reinforces the hypothesis that including periodontal therapy in the comprehensive care of diabetic patients may play an important role in improving glycemic profiles.

Based on the limitations identified in the reviewed studies, it is possible to conclude that, although there is promising evidence regarding the positive impact of periodontal therapy on glycemic control in patients with type 2 diabetes, the variability in study designs and participant characteristics limits the ability to draw definitive conclusions. The heterogeneity of patients—considering factors such as the severity of periodontitis and individual glycemic control—as well as differences in periodontal treatment protocols and follow-up durations, underscores the need for future, more robust and personalized research. A more tailored approach that takes into account the individual characteristics of each patient may be essential to clarify the therapeutic effects of periodontal therapy on glycemic control and to contribute to a more effective management of these interconnected conditions.

Integrated and Interdisciplinary Approach in Management

The integrated and interdisciplinary approach in the management of patients with type 2 diabetes and periodontitis has proven to be essential for improving clinical outcomes [25]. The collaboration between oral

health professionals and endocrinologists is crucial for the effective control of both diabetes and periodontal health [26]. Communication between these two areas must be clear and continuous, enabling professionals to engage the patient in a coordinated and personalized manner. In this way, endocrinologists can monitor and adjust diabetes treatment, while dentists address periodontal conditions that may worsen glycemic control, creating a holistic and effective approach [25].

For this integration to be successful, it is crucial to establish well-defined referral pathways and educational programs for patients. When a dentist identifies signs of periodontitis in diabetic patients, a prompt and appropriate referral to an endocrinologist can prevent severe complications. Additionally, educating patients about the interconnection between diabetes and oral health is essential to improve treatment adherence and raise awareness of the importance of managing both conditions. Well-informed patients are more likely to adopt healthier behaviors, such as maintaining oral hygiene and stricter glycemic control, which positively impacts their quality of life and disease management [27].

Integrated management protocols should be developed collaboratively among different specialties, including dentistry, endocrinology, and, when necessary, other areas such as nutritionists and psychologists. These protocols may include periodic oral health evaluations, appropriate periodontal treatment, and continuous monitoring of glycemic levels. Implementing non-surgical periodontal treatment along with regular medical follow-up can lead to significant improvements in both glycemic control and periodontal health. Moreover, joint treatment can reduce the risk of complications associated with type 2 diabetes, such as cardiovascular diseases and neuropathies, creating a positive cycle for the patient [28].

Finally, the implementation of integrated protocols requires the formation of well-trained healthcare teams committed to a holistic view of patient health. Evidence suggests that adopting an interdisciplinary approach can optimize treatment outcomes, promote patient well-being, and reduce the burden on healthcare systems. The involvement of various healthcare professionals provides a comprehensive view of the patient, addressing both clinical needs and those related to behavior and lifestyle. This not only improves treatment adherence but also strengthens preventive care, which is essential for the effective management of chronic diseases such as diabetes.

Barriers and Challenges in Integrated Care

The integration between medical and dental fields in the management of patients with type 2 diabetes (T2D) and periodontitis still faces multiple barriers that compromise the effectiveness of care. One of the main challenges is the lack of mutual knowledge between the specialties. Many physicians are unaware of the impact of periodontal diseases on glycemic control, and several dentists do not recognize the systemic effects of diabetes on periodontal tissues [29]. This lack of understanding hinders the development of a collaborative approach and can delay important interventions in both medical and dental areas [30].

Another significant obstacle is limited access to dental care, especially in more vulnerable populations, who often already face disparities in access to healthcare services. Patients with diabetes may encounter financial, logistical, or structural barriers to accessing periodontal treatments, and even when continuous medical care is available, dental follow-up tends to be neglected [31]. The absence of integration between primary and specialized care levels also contributes to fragmented care.

Behavioral aspects and treatment adherence constitute another major challenge. Patients with T2D and periodontitis need to adopt several lifestyle changes, such as dietary control, smoking cessation, physical activity, and maintaining strict oral hygiene. However, engagement with these practices is influenced by emotional, social, and educational factors, which are often not adequately addressed in the traditional healthcare model [32, 33]. Low awareness of periodontal risk and underappreciation of oral health also negatively impact adherence.

Thus, overcoming these barriers requires actions at multiple levels: continuous education for healthcare professionals, incorporation of interdisciplinary guidelines into public policies, creation of formal referral pathways between physicians and dentists, and implementation of educational strategies aimed at patient awareness and empowerment. Integrated and personalized clinical protocols may be a promising alternative to optimize outcomes and reduce complications associated with the poor management of these chronic diseases [34, 35].

IV. Conclusion

Given the existing evidence, although promising, there remains a critical need for more well-designed and randomized clinical trials to more robustly confirm the effects of periodontal treatment on glycemic control in patients with type 2 diabetes. Most studies present methodological limitations, such as small sample sizes and variability in intervention protocols, which hinder the generalization of results. Thus, future research should consider long-term follow-up and rigorous control of confounding variables, such as smoking, medication use, and adherence to therapeutic guidelines, in addition to adopting standardized criteria for assessing clinical and metabolic outcomes.

Furthermore, it is essential that oral health be incorporated into diabetes management guidelines, recognizing the bidirectional relationship between these two conditions. Primary healthcare, as the gateway to the healthcare system, plays a strategic role in the integration between medical and dental teams, potentially coordinating educational, preventive, and timely referral actions. Public health programs targeting the diabetic population should include systematic screening and periodontal treatment, especially in communities with restricted access to dental services. This integrated approach can contribute not only to glycemic control but also to reducing chronic diabetes complications and improving the overall quality of life of patients.

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