THE IMPACT OF TYPE 2 DIABETES ON ORAL HEALTH AND PERIODONTAL DISEASE

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Abstract

Diabetes mellitus (DM) has been called an epidemic and is a worldwide health concern. DM has a significant negative impact on a diabetic's overall health, particularly when it comes to vascular, cardiac, renal, ophthalmic, or neurological complications. Among all the organs and systems impacted by diabetes mellitus is the oral cavity. Higher prevalence leads to the development of significant diseases such periodontitis, changes in salivary flow, fungus infections, oral cancer, and possibly malignant illnesses of the mouth. The impact of diabetes on oral health is often overlooked, but it is essential for diabetic individuals to understand the increased risk of oral complications and the importance of maintaining good oral hygiene. Proper management of diabetes, along with regular dental check-ups and professional cleanings, can help prevent or minimize the oral health issues associated with diabetes. Patients with diabetes and other health professionals do not have enough knowledge about oral health, despite a large body of research supporting the link between dental health and type 2 diabetes. In order to identify diabetes early and send patients to oral health experts on time, the treating physician must be knowledgeable about the many oral symptoms of the disease. It is crucial for healthcare professionals to educate diabetic patients about the importance of oral health and its relationship to overall well-being.

Keywords: Diabetes Mellitus, Oral, Periodontal, Diseases, Type 2 Diabetes, Periodontitis, Complications.

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Introduction

Over the last several decades, medical practitioners have been grouped into numerous specializations and subspecialties that focus on different bodily systems and organs. In this review, we will focus on two highly prevalent diseases—oral diseases and Diabetes Miletus—to illustrate how the human organism is a unity made up of an infinite number of biologic processes that are so strongly linked that abnormalities in any part of the body and/or its processes may have profound effects in many other body areas [1].

Among the most prevalent types of chronic illness are oral disorders, which have a significant impact on general health and well-being, self-worth, and life quality. Despite the fact that general health neglects oral health, the World Health Organization (WHO) estimates that 50% of the world's population suffers from oral ailments, with severe periodontal disease and untreated dental caries being the most common [2]. Although every underlying cause of oral health has not yet been found, a number of risk factors have been proposed, which may contribute to our comprehension of the basic principles of the pathophysiology of oral diseases. The two most significant determinants are smoking and dental hygiene, although diabetes has also been demonstrated to be a significant factor [3].

In fact, type 2 diabetes is a chronic condition with oral symptoms that coincide and impact dental care. Increased risk of oral illnesses including periodontal damage is partly due to higher levels of pro-inflammatory mediators in poorly managed diabetes. For instance, the sixth most common consequence of diabetes is periodontal disorders, such as gingivitis and periodontitis. A complicated two-way relationship between type 2 diabetes and dental disorders has been suggested by reports that oral health may influence type 2 diabetes risk and its metabolic regulation [2].

On the other hand, there is a greater body of data suggesting that type 2 diabetes develops before periodontal problems. According to earlier research, periodontal disorders, tooth loss, high decaying, missing, and filled tooth values, and worse oral health-related quality of life ratings are all strongly correlated with the duration and severity of diabetes. On the other hand, a new meta-analysis notes a high degree of study heterogeneity and a non-significant correlation between poorly managed type 2 diabetes and the risk of periodontitis. nly a small subset of its attributes have been employed as study objectives in the past, and no prior research has concurrently examined the many aspects of oral health. Moreover, there are surprisingly few studies that are age- and gender-specific, despite the gender disparities in diabetes prevalence and the burden of age-related oral health [4].

oral diseases may be one distant cause of low-grade systemic inflammation, despite the fact the mechanisms behind this relationship are yet unknown. This correlation may help to explain the higher risk of poor metabolic control in issues associated to diabetes mellitus as well as the detrimental impact of DM on periodontal health. There is compelling evidence that individuals with DM have a markedly greater frequency, severity, and development of periodontal disease [5].

According to a number of studies, people who either have untreated diabetes or struggle to maintain control over their blood sugar levels are 2-3 times more likely to develop periodontitis, with glycemic control being the key risk factor [6]. Furthermore, people with diabetes had a greater frequency of progressing periodontitis, according to long-term research. For instance, cross-sectional epidemiologic studies have shown that when diabetes is present, individuals with periodontitis experience a more severe and widespread loss of periodontal tissue support [7]. Successful periodontal therapy has been shown in several controlled human trials to lower levels of circulating C-reactive protein (CRP) and tumor necrosis factor (TNF)-α in people with diabetes, indicating its active involvement in inflammation [8]. In this review, we outline the shared processes between diabetes mellitus (DM) and oral health and provide a brief overview of the data supporting the link between these conditions and problems connected to diabetes.

Relationships between diabetes and periodontal disease

The relationship between periodontal disease and diabetes has been thoroughly investigated via the use of several cross-sectional, case-control, cohort, and interventional studies. Numerous evaluations of the scientific literature have addressed it [9]. Nelson et al. investigated the incidence, prevalence, and correlation between periodontal disease and Pima Indians' non-insulin-dependent diabetes mellitus in 1990. Type 2 diabetes (T2DM) was highly prevalent in this group. Patients with T2DM had a significantly greater prevalence of periodontitis

than did normal participants in the 3219 subjects that were analysed [10].

A study conducted in Saudi Arabia looked into the possibility of a reciprocal relationship between type 2 diabetes and periodontitis. For the control patients, Quadri et al. created a 2:1 sample with an average research sample age of around 38 years old. In addition, the study's findings demonstrated a strong correlation between periodontal disease and poor oral hygiene, khat usage (which is common in this particular region), and type 2 diabetes with hypertension and periodontitis [11].

In another study, 129 patients were categorised into four groups based on whether or not they had diabetes at the Altamash Institute of Dentistry in Pakistan. Patients with periodontal disease were then checked on every three and six months. When the pocket probing depth (PPD) was 4 < 6 mm, both non-surgical and surgical treatment methods were used to treat periodontal disease. Non-surgical alternatives included root planing and supragingival and subgingival scrubbing. PPD > 6 mm was reduced by modified flap surgery with scaling and root design [12]. Individuals with diabetes (PD or not) saw an average drop in HbA1c levels of 0.3% after three months of therapy; after six months, the average decline was 0.8% and 1%, respectively. Furthermore, compared to six-month follow-ups, there was only a marginal improvement in the periodontal condition of periodontal disease participants who were both diabetic and non-diabetic. Overall, this study found that patients with diabetes and periodontal disease or non-diabetics with periodontal disease had substantially higher PPD than non-diabetics or diabetics without periodontal disease at each of the three check-ups.

According to many research, diabetic individuals receiving non-surgical treatment for periodontal disease had a moderate 0.4% decrease in their mean HbA1c score. The average drop in HbA1c levels among diabetic participants getting scaling was 0.3% after three months. There was a 37% decrease in microvascular complications and a 21% decrease in diabetes-related mortality for every 1% decrease in HbA1c levels [12]. In one study, the effects of surgical oral interventions, like dental extractions, were examined in relation to specific molecules (hepatocyte growth factor (HGF), tumour necrosis factor-α (TNF-α), interleukin 18 (IL-18), matrix metalloproteinase 9 (MMP-9), and markers of bone destruction, such as osteoprotegerin (OPG), kappa B nuclear factor receptor activator ligand (RANKL), and markers of oxidative stress—total oxidant status (TOS), total antioxidant capacity (TAC), and whether there is a relationship between these molecules and HbA1c levels. TNF-α, IL-18, MMP-9, TOS, OPG, and RANKL were higher in T2DM participants than in pre- and post-extraction controls. HbA1c levels were well predicted by IL-18, TNF-α, MMP-9, OPG, RANKL, and TOS at baseline. Three months following surgery, oxidative state biomarkers and HbA1 showed a substantial connection [13].

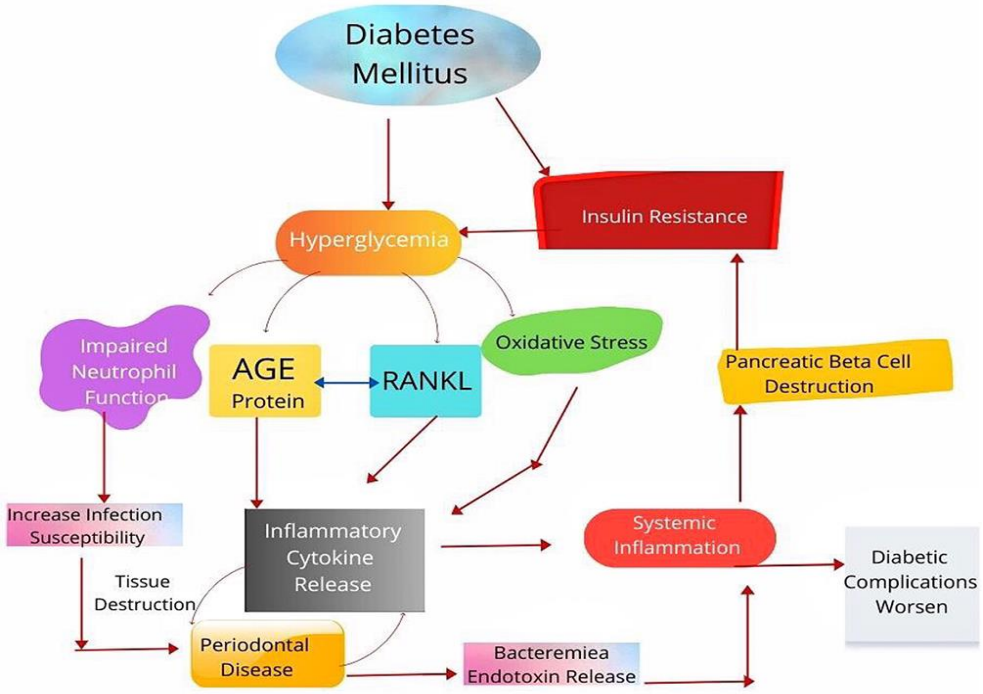

Figure 1: Association between periodontal disease and diabetes mellitus [13]

Mechanisms Connecting Periodontal Diseases with Diabetes

Sustained hyperglycemia from poorly managed diabetes mellitus causes an increase in the inflammatory response in the periodontal tissue. This, in turn, activates the RANK/RANK-Ligand (RANKL) axis, causing an increase in osteo-clasto-genesis and the breakdown of the alveolar bone. The process culminates in the clinical attachment loss, a hallmark of Parkinson's disease [14]. Figure 2 summarizes the scientific information currently available about the molecular processes between DM and Periodontal Diseases.

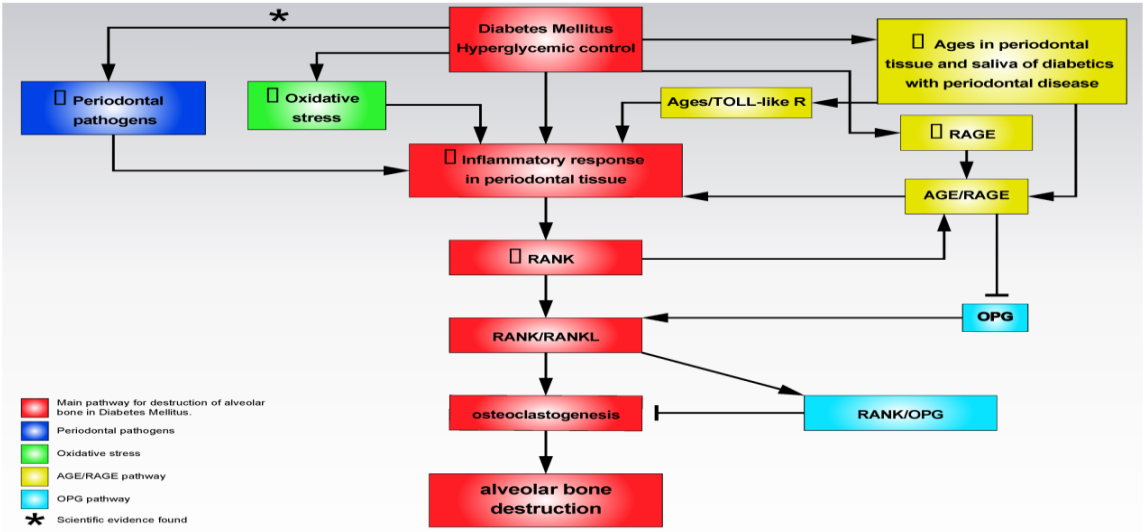

Figure 2: Poorly controlled diabetes mellitus causes persistent hyperglycemia, which sets off an inflammatory response in the periodontal tissue. This, in turn, activates the RANK/RANKL axis, leading to an increase in osteoclastogenesis and alveolar bone degradation, ultimately culminating in tooth loss, one of the main symptoms of periodontitis. The inflammatory response in periodontal tissue is also triggered by an increase in the quantity of periodontal pathogens, reactive oxygen species (ROS), and the production of advanced glycation end products (AGE) and its receptor (RAGE). The balance between the receptor activator of nuclear factor κB (RANK), RANK-Ligand (RANKL), RANK, and osteoprotegerin (OPG) will be crucial for preserving periodontal bone homeostasis [14].

Infectious and immunologic oral diseases

Oral Cavity Infections: Diabetes mellitus patients have impaired immune systems, which makes them more vulnerable to oral cavity infections. Bacteria in the mouth interact with food particles to build plaque, which can lead to dental caries, gingivitis, halitosis, and mouth ulcers. Peptostreptococcus prevotii, Fusobacterium nucleatum, Actinomyces israelii, Peptostreptococcus sanguis, Prevotella intermedia, and Streptococcus intermedius are the bacteria that are frequently found in the oral cavity of diabetics who have an oral infection [15].

Bacterial growth is promoted by the elevated glucose levels in the saliva of diabetes individuals. Uncontrolled diabetes increases the risk of bacterial infections reoccurring and spreading from the mouth to other parts of the body. Previous investigations have reported the presence of deep neck infections in persons with diabetes [16].

Periodontal Disease: Chronic periodontal disease causes the teeth's supporting tissues to gradually deteriorate. It can also cause pockets to form, recession, or both, and can end in tooth loss due to the significant loss of alveolar bone. It is often known that one of the primary causes of tooth loss in people with diabetes is periodontal disease [17].

A meta-analysis of four studies including 3,524 individuals (over the age of eighteen) revealed that people with diabetes are twice as likely as people without diabetes to acquire periodontal disease [18]. Furthermore, there are significant racial differences in the incidence of periodontal disease among individuals who also have diabetes. While Fernandes et al. [19] showed noticeably higher rates for African Americans of Gullah ancestry with T2DM (70.6%), national prevalence estimates of periodontal disease for African Americans with T2DM have been reported at 59.7%. Changes in host response, collagen metabolism, and vascularity are some of the reasons that have been suggested to

explain why people with uncontrolled diabetes mellitus are more susceptible to periodontal disorders. The bacterial assault of periodontitis triggers an increased inflammatory response in those with poorly managed type 2 diabetes. For these individuals, a hyper-inflammatory response in addition to compromised wound healing and repair may exacerbate the inflammatory response and periodontal tissue damage [17].

In patients with type 2 diabetes and other impaired people, the host inflammatory response seems to play a crucial role in determining the severity and susceptibility to periodontitis. Additionally, data points to the possibility that bacteremia brought on by periodontitis would raise levels of proinflammatory cytokines and reactive oxygen species in the blood, which will contribute to the etiopathogenesis of the metabolic syndrome and worsen insulin resistance. Glycemic regulation may be deteriorated by the chronic inflammatory condition that untreated periodontitis causes, which may lead to insulin resistance [19].

A recent research by Bandyopadhyay et al. [20] found a strong correlation between the advancement of periodontal disease and the state of diabetes management. The study sample consisted of Gullah African Americans with T2DM who had no recent clinical history of periodontal treatment. Untreated periodontitis presents an inflammatory challenge to the patient, and the patient may benefit locally and systemically from the decrease of periodontal inflammation [17].

Every 1% point drop in HbA1c levels is thought to reduce diabetes-related microvascular complications by 35%; moreover, a 1% absolute drop in HbA1c levels may lower the risk of any diabetes-related death by 21% [17].

The oral microbiota: There are several advantages to the intricate biological symbiotic relationship between the human body and the microbiome. A diversified oral microbiome is the outcome of millions of years of co-evolution, reciprocal adaptation, and functional integration that led to this symbiosis [21].

Such biofilm formation can happen in the oral cavity in a number of locations, including cavities inside teeth, the area between the dental pulp and the enamel (fissure biofilm), the subgingival area (which is primarily made up of anaerobe species), and artificial surfaces like dental fillings [22].

An ordered series of processes leads to the formation of dental plaque, which is a highly species-diversified microbial population that is both physically and functionally structured. A number of distinct stages are involved in the formation of plaques: acquired pellicle formation; co-adhesion, which causes secondary colonisers to adhere to pre-attached cells; multiplication and biofilm formation; and, finally, detachment. Reversible adhesion involves weak, long-range physicochemical interactions between the cell surface and the pellicle and can lead to stronger adhesin receptor-mediated attachment. The human microbiome must coexist in harmony with the host in order for the body to be healthy. Dysbiosis results from upsetting this equilibrium, and it is linked to a number of systemic illnesses, including obesity, hypertension, depression, atopic (inflammatory or autoimmune) diseases, asthma, vascular/neuronal diseases, metaplasia, and DM. Dysbiosis plays a crucial part in the development and occurrence of many illnesses as it may both cause and be a symptom of the systemic diseases that are discussed [9] .

Five hundred residents of three distinct Japanese nursing homes took part in a recent study that looked at the salivary microbiome. More than 700 different bacterial species were found in the saliva sample microbiome study. Following the extraction of genomic DNA from 15 senior people, three of whom had type 2 diabetes, it was shown that the oral-bacterial population in the T2DM group differed from that of the non-diabetic group [23].

Another important periodontopathogen that has been connected to is P. gingivalis. According to a research on 37 individuals with diabetes who had either periodontitis or not, 27.03% of the patients had p. gingivalis [24]. Aoyama et al. found similar outcomes, noting that uncontrolled DM patients also had worsened clinical attachment level and bleeding upon probing [25].

Dental caries: Also referred to as tooth decay, dental caries are brought on by a deterioration of the tooth's tissues. Tooth decay arises from the bacteria present in dental plaque on teeth, which generates acid that erodes tooth tissues, including enamel. Patients with diabetes may be more susceptible to dental caries development due to a number of related oral disorders, such as xerostomia and high dental plaque levels [26].

Oral candidiasis: Fungal infections, especially those caused by species of Candida sp., cause oral candidiasis. Common clinical signs include patches of lingual depapillation and commissural cheilitis over the oral mucosa, as well as large reddish patches (erythematous candidiasis).

White lumps that resemble yoghurt or milk clots (speudomembranous candidiasis) may be seen in people with diabetes mellitus. Typically, oral candidiasis manifests as pain, burning, or discomfort [27].

Oral cancer: A malignant tumour that affects the lips, oral cavity, or oropharynx is known as oral cancer. About 90% of instances of oral squamous cell carcinoma result in a 50% 5-year fatality rate. It is unclear why diabetics are more likely to acquire oral cancer, while clinical, biochemical, and molecular explanations have been put forth [28].

Oral potentially malignant disorders (OPMDs): OPMDs are a large group of mucosal disorders that may increase the risk of developing oral cancer. They include oral leukoplakia, oral lichen planus (OLP), proliferative verrucous leukoplakia, erythroplakia, and actinic cheilitis. Subjects with DM are more likely than the general population to have leukoplakia and OLP, two common OPMDs linked to high risks of malignant transformation [29].

Burning mouth: Poor glycemic control, metabolic changes in the oral mucosa, angiopathy, candida infection, and neuropathy are all linked to diabetes patients' burning mouth feeling or dysesthesia. In some individuals, neuropathic pain may present as tingling, burning, electric shock, or stabbing sensations, all of which can be quite incapacitating. These pain sensations are linked to the degree of worry, sadness, and sleep disruption and have a significant impact on both physical and psychological functioning [30].

Oral mucosa modifications: Diabetes may be linked to a number of oral mucosa modifications, including geographic tongue, coated and fissured tongue, recurrent aphthous stomatitis, and some premalignant diseases like lichen planus. Although the extent to which these individuals are susceptible to alterations in the oral cavity is still up for debate, factors such as inadequate management of diabetes, immunological changes, decreased blood supply in the microcirculatory system, xerostomia, changes in the content and flow of saliva, and smoking have all been brought up. Since OLP has an underlying autoimmune mechanism and type 1 diabetes is regarded as an autoimmune illness, people with type 1 diabetes experience OLP more frequently than those with type 2 diabetes. In diabetic individuals, acute hyperglycemia alters the immune system's response[31].

impaired oral wound healing: One well-known side effect of oral surgery is the delayed healing of soft and hard tissues in diabetes patients. According to several research, effective elements in these individuals' extended wound healing include delayed vascularization, reduced blood flow and hypoxia, a decrease in innate immunity, decreased growth factor synthesis, and psychological stress [31].

Xerostomia: Salivary dysfunction is a complication of diabetes that can result in altered salivary content and reduced salivary flow. Among diabetic patients, the estimated global prevalence of xerostomia varies from 34% to 51%. Xerostomia can cause a variety of issues, including trouble swallowing, speaking, and eating. In fact, the quality of life of patients may suffer as a result. Adults with diabetes have been found to have reduced salivary function in several investigations. Although the exact cause is unknown, it may be connected to autonomic neuropathies, polyuria, and microvascular modifications and abnormalities in the salivary glands' basement membranes. Salivary glucose levels and the severity of xerostomia are significantly correlated. Notably, diabetics with inadequate glycemic control exhibit the highest degree of salivary dysfunction [31].

Bad breath, or halitosis: a symptom that can be caused by periodontitis, caries, or poor oral hygiene. people with diabetes mellitus (DM) are more likely to develop halitosis due to the high frequency of these conditions in people with diabetes [32].

Information and Attitude Towards Oral Complications

Previous research has demonstrated that diabetic individuals have little information about the risks associated with oral health and were unaware of the reciprocal relationship between periodontal disease and diabetes mellitus. Several barriers kept the carers from offering appropriate treatment in a 2017 study on the knowledge and behaviours of diabetes care providers in dental health care [33]. These included a lack of appropriate referral systems, guidelines or dental health screening tools, and insufficient understanding of the reciprocal link between diabetes and oral health. Nonetheless, prior research has indicated that individuals with diabetes who get information on oral health from healthcare providers and have improved education in this field have a solid understanding of oral health. Patients who have more knowledge about the connection between diabetes and dental health adopt healthier dental habits [34].

Conclusion

Diabetes and periodontal disease have a same pathobiology and are closely connected. Diabetes may be significantly influenced by inflammatory processes that occur during periodontal disease, and insulin resistance most likely speeds up the progression of periodontal disease. Other disorders linked to delayed wound healing include dental caries, burning mouth syndrome, changes in saliva output, impaired taste perception, and halitosis. All of these conditions lead to significant consequences that significantly aggravate the already compromised health status of individuals with diabetesIndividuals with diabetes must therefore be vigilant in maintaining good oral hygiene and seeking regular dental care to prevent and manage periodontal disease and other related oral health issues. By addressing these conditions, individuals can help to mitigate the impact of diabetes on their overall health and well-being. It is crucial for healthcare providers to recognize the interconnectedness of diabetes and oral health and to provide comprehensive care that addresses both aspects of the individual's health.. Due to the oral cavity's frequent involvement in these individuals, care of the condition calls for a multidisciplinary approach and appropriate patient education protocols. In addition to extending the preventive and screening initiatives required to slow the development of these diseases, the involvement of oral health care professionals in strategies to identify individuals at risk for diabetes will, importantly, provide a portal for people who do not regularly see a physician to enter the general health care system.

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