

# Diabetes and Periodontitis—A Dental Hygienist’s Perspective

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**Abstract** Several decades of research of the interrelationships between diabetes and periodontitis have evolved into a significant body of knowledge that should be incorporated into dental practice. However, there may be a delay in implementing this important information into everyday patient care. Oral healthcare providers (i.e., dentists and dental hygienists) should be progressively engaged in changing the trajectory of the epidemics of diabetes and periodontitis. This article synthesizes the cumulative evidence on the diabetes-periodontitis link, proposes ideas for risk stratification of dental patients with diabetes and periodontitis, and builds a case for the development of a risk-prediction model that provides for the earliest identification of dental patients who have dysglycemia.

**Keywords** Periodontal disease · Periodontitis · Diabetes-periodontal disease relationship · Periodontitis and glycemic control · Periodontitis and prediabetes · Diabetes screening in dental office

## Introduction

It was once said that, “scientific study that is not translated and used in daily practice ultimately is wasted.”<sup>1</sup> And, so it may be with our delay in integrating, into daily practice, the evidence of the interrelationship between diabetes and periodontitis. This is medical science we have known about for decades. Has this important body of evidence influenced the way we practice as oral healthcare providers (i.e., dentists and dental hygienists)?

Survey data of practice trends suggest that this well-disseminated knowledge base has had very little impact on the way dentists and dental hygienists (also known as oral healthcare providers, OHCPs) care for people who have diabetes and periodontal disease or those who are at risk for diabetes and periodontal disease [1–6]. Other research indicates that OHCP’s collaboration with the medical community on case management of patients with diabetes is sub-optimal [7, 8] and may be hindered by a lack of knowledge regarding the evidence base to support the interrelationship between diabetes and periodontitis [7, 9].

This review proposes that OHCPs should be progressively engaged in changing the trajectory of the epidemics of diabetes and periodontitis. It was over 20 years ago when Løe suggested that periodontal disease is the 6th complication of diabetes [10]. Since then, much has been written about how OHCPs are uniquely positioned to screen patients for diabetes and prediabetes [11–13]. Just as screening dental patients for hypertension became a standard of care 50 years ago, screening for diabetes should become a standard of care and no longer considered optional in routine dental visits. Beyond basic screening for diabetes, OHCPs should implement risk

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stratification strategies that identify dental patients who have diabetes that has not been diagnosed with or without periodontal disease, dental patients who have periodontitis who are at risk for diabetes, and dental patients with prediabetes. This article also advocates for the development of a risk-prediction model that provides for the earliest identification of dental patients who have dysglycemia, before the onset of overt diabetes. This will allow OHCPs to intervene with patient education targeting life style modification that may avert or delay the onset of diabetes.

### Intervention Treatments for Diabetes and Periodontitis Cannot be Optional

Because diabetes and periodontitis are interrelated chronic disease states, individually they act to amplify total inflammatory burden. Importantly, when both diseases are present, total inflammatory burden is synergistically increased.

In the past, the responsibility for the diagnosis of diabetes and care of people with diabetes has largely fallen to the medical community and the responsibility for diagnosis of periodontitis and care of people with this condition has fallen to OHCPs. However, the magnitude of the epidemic of diabetes and periodontitis compels all healthcare providers to dismantle models of traditional silo care that have separated dentistry and medicine. Medical practitioners must incorporate strategies for intervention of periodontitis, and OHCPs must incorporate strategies to intervene in diabetes and dysglycemia. Interprofessional screening and referral and collaboration in the co-management of these cases is essential.

Statistics from around the world bear witness to an epidemic of diabetes and a very high prevalence of periodontitis. The interrelationship of these disease states places at the door step of OHCPs an unprecedented opportunity to intervene in the trajectory of these disease trends.

According to a 2014 report of the International Diabetes Federation, 387 million people, or 8.3 % of the world population, have diabetes; 179 million of people with diabetes are undiagnosed—almost half the cases [14]. By 2035, it is expected that 592 million people will have diabetes. Worldwide prevalence of prediabetes is increasing, with 470 million people projected to have prediabetes by 2030 [15]. Prediabetes, defined by the American Diabetes Association (ADA), is when glucose levels are higher than normal (hyperglycemia) but not high enough to be classified as diabetes [16••]. The criteria that delineate prediabetes are impaired fasting glucose (IFG),<sup>2</sup> and/or impaired glucose tolerance (IGT),<sup>3</sup> or glycosylated/glycosylated hemoglobin (HbA1c).<sup>4</sup> Persistent IFG

and/or IFG, or elevated HbA1c over time, usually progresses to diabetes [17•].

Worldwide prevalence of periodontitis varies among people around the world; however, recent reports suggest that severe periodontitis affects 11 % of the world population, with prevalence and severity increasing with age, ethnicity, and geographic locations [18, 19]. It is important to note that this percentage does not include mild and moderate cases of periodontitis. At the time this article was written, no data on the worldwide prevalence of mild and moderate periodontitis could be located. However, the prevalence of all periodontitis (mild, moderate, and severe cases) in the USA is about 47 % in people age 30 and older [20]. Extrapolation of this statistic suggests that close to half the world's population has periodontitis.

### Evidence on the Interrelationship Between Diabetes and Periodontitis That Should Be Incorporated into Everyday Patient Care

The influence of diabetes on the severity of periodontal disease was first reported in 1964 [21]. Fifty years of research since this initial report has provided a body of evidence that supports a number of precepts that should guide OHCPs in identifying people, in various categories of diabetes and periodontitis, who would benefit from patient-centric care. So, what evidence should be incorporated into everyday patient care? Significant evidence has been established to support the following:

- Both types 1 and 2 diabetes increase the risk for periodontal disease pathogenesis [22–26].
- Poorly controlled diabetes increases the risk for deterioration of the periodontium, including clinical attachment loss, progression of periodontal pocket depth, and alveolar bone loss [27–29]. There may be a “dose-response” relationship: as glycemic control worsens, the greater the adverse effect diabetes has on periodontal health [30].
- Periodontal infection/inflammation is a risk factor for poor glycemic control and compromised diabetes management [28, 31].
- Periodontal disease contributes to increased risk for complications of diabetes, such as retinopathy, neuropathy, nephropathy, proteinuria, end-stage renal disease, and cardiovascular disease [32–40].
- Chronic periodontal inflammation may increase the risk for type 2 diabetes [41••, 42–46, 47•].
- Although the predominance of evidence suggests that treatment of periodontal disease may improve glycemic control, this is inconclusive [48–57]. However, a recent Cochrane Review concluded that there is insufficient evidence that improvement in glycemic control can be

<sup>2</sup> 100–125 mg/dl or 5.6–6.9 mmol/l

<sup>3</sup> 140–199 mg/dl or 7.8–11.0 mmol/l

<sup>4</sup> 5.7–6.4 %

maintained after 4 months following treatment using non-surgical treatment modalities [58•]. The review reported that treatment of periodontal disease is associated with improved glycemic control and about a 0.4 % reduction in HbA1c; however, maintaining clinical improvement in glycemic control beyond 6 months can only be accomplished through ongoing professional periodontal treatment. Further, no one periodontal therapy is more effective than another in improving glycemic control in people with diabetes and it is inconclusive whether adjunctive therapies would improve clinical outcomes of periodontal treatment.

- Negative changes in periodontal indices may signal unidentified prediabetes [59]. For example, undiagnosed abnormal fasting plasma glucose may be detected by observing changes in periodontal tissues. Deepening periodontal pockets are associated with development of glucose intolerance [60]. Evidence suggests that periodontitis is associated with decreased beta-cell function and impaired glucose metabolism, characteristic of prediabetes, before the onset of diabetes [61–63].

### Differentiating Risk for Diabetes, Prediabetes, and Periodontitis in Dental Patients

Based upon the strong evidence of an interrelationship between diabetes and periodontal disease, OHCPs should consider how dental patients in five risk categories may benefit by more comprehensive, profile-specific care. Identifying people who are in these groups allows OHCPs to be more effective by individualizing patient care and potentially averting or delaying the onset of diabetes and/or periodontitis. Following below is a proposal on how these at-risk patient groups should be stratified, along with ideas on how care may be customized.

#### Category 1: Patients with Diabetes but No Apparent Periodontal Disease

For people in this category, it is important to determine whether the patient's diabetes is well-controlled or poorly controlled. Request that patients with diabetes provide information on their most recent HbA1c results, which will provide an average of blood sugar control over the past 2 to 3 months. The goal in diabetes care is to maintain blood sugar levels as close to normal safely as possible [64]. Maintaining HbA1c to below or around 7 % reduces complications of diabetes which may also lower the risk for periodontitis. On the contrary, an increase in blood glucose may signal increased susceptibility to periodontitis. Small changes in A1C can make a big difference in risk for diabetes-related complications.

Patients already diagnosed with diabetes who do not have a treating physician are at high risk for cardiovascular events and should be referred to a physician [65]. It is also important to carefully monitor patients with diabetes for changes in periodontal status and educate them about increased risk for infections, including periodontal diseases, and review the ABCs of diabetes management.<sup>5</sup> There is additional information that OHCPs should collect from patients with diabetes. Table 1 provides a list of important documentation associated with the status of a patient's glycemic control and diabetes case management.

#### Category 2: Patients with Diabetes Who Also Have Periodontal Disease That Is Untreated

As discussed, untreated periodontitis may worsen glycemic control. Accordingly, people with untreated periodontitis should be educated about the impact periodontal disease may have on glycemic control, and the increased risk for complications of diabetes. Patients should be advised that treatment of periodontitis may improve glycemic control and as a result reduce insulin needs. Encourage acceptance of the recommended periodontal treatment plan. For patients who refuse treatment, they should advise their physicians of the ramifications this might have to glycemic control. By requesting information on patients' last HbA1c results and updating records accordingly, OHCPs can monitor glycemic control against worsening periodontal indices (e.g., bleeding upon probing [BOP], increased pocket depth [PD]). Health professionals who care for people with diabetes should be vigilant in looking for signs and symptoms of periodontitis.

#### Category 3: Patients with Diabetes Who Also Have Periodontitis That Has Been Treated

Periodontal maintenance scheduled in 3-month intervals may be effective in sustaining periodontal health in most people post treatment [66]. However, patients with diabetes that is poorly controlled may have a more rapid recurrence of deep pockets, and their long-term response to treatment may be compromised [67, 68]. Accordingly, it is important to ask patients with diabetes for information on glycemic control, e.g., HbA1c. After completion of

<sup>5</sup> A is for the A1C test (HbA1c), the goal for most people is below 7; B is for blood pressure, the goal for most people with diabetes is below 140/80; C is for cholesterol, the goal for most people with diabetes is LDL cholesterol under 100 mg/dl, triglycerides under 150 mg/dl; HDL cholesterol above 40 mg/dl for men, and above 50 mg/dl for women. American Diabetes Association and the American College of Cardiology; <http://www.diabetesselfmanagement.com/managing-diabetes/complications-prevention/taking-diabetes-to-heart/abcs-of-diabetes/>; accessed 30 November 2015.

**Table 1** Important documentation associated with the status of a dental patient's glycemic control and diabetes case management

In caring for dental patients with diabetes, it is important to document the status of the patient's glycemic control and other aspects that will inform case management and interprofessional collaboration with other practitioners caring for the patient.

- Are there medical changes or recent illnesses or symptoms suggestive of complications of diabetes?
- Are there changes in medication?
- When was the patient's most recent physical exam; what were the findings?
- How often does the patient visit his/her physician?
- Does the patient see a diabetes educator, if so, who, and what is the date of most recent visit?
- Is his/her diabetes being managed by diet and exercise or medications?
- How long has the patient been taking insulin; what is the route of insulin (by mouth, injection, or insulin pump)?
- What is the patient's blood pressure while seated, at rest in the dental operatory?
- What were the results of the patient's most recent HbA1c, what is his/her frequency of testing; is there a significant change over the last 2 years?
- How often does the patient do finger sticks to check blood sugar; does he/she carry a glucometer?
- Does the patient have a history of hypoglycemic episodes or symptoms and if so, how often do these occur?
- Does the patient adherence to medication regimens and lifestyle modifications recommended by his/her physician or other members of the diabetes care team?
- What was the date of the patient's most recent eye examination; have there been changes in his/her eye sight?
- What was the date of the patient's most recent foot examination; have there been signs of foot infections?
- Does the patient use tobacco, and if so, has he/she been referred for cessation counseling?
- Does the patient consume excessive alcohol, and if so, has he/she been counseled to seek care?
- Is the patient experiencing emotional distress or depression, and if so, has he/she been referred for counseling?
- Has the patient authorized the exchange of health-related information with members of the diabetes care team?

active periodontal therapy, patients with diabetes should be scheduled for periodontal maintenance with intervals selected according to response to treatment and glycemic control. Patients should be educated about the impact of periodontal infection on glycemic control and encouraged and empowered to take responsibility for managing their diabetes and periodontal health. Risk factors for periodontitis which may influence diabetic complications [69], and when periodontal indices do not improve (e.g., BOP, increased PD), should be considered; it may be beneficial to move the patient from periodontal maintenance to active therapy [69].

#### Category 4: Patients Who Have Been Diagnosed with Periodontal Disease but Not Diagnosed with Diabetes

Periodontal infection is positively associated with impaired glucose intolerance, and given the role of chronic periodontal inflammation in increasing the risk for incident diabetes, it is important to routinely screen patients who have periodontitis, for diabetes or prediabetes. Patients should be counseled that treatment of periodontal disease may reduce inflammation throughout the body and that periodontal disease, if left untreated, may be a risk factor for type 2 diabetes. Borrell and colleagues found that individuals who self-reported a cluster of risk factors such as family history of diabetes, hypertension, and high cholesterol and presented with clinical evidence of periodontal disease have a probability of 27–53 % of having diabetes [70]. Saito and colleagues reported that subjects who developed IGT were significantly more likely to have deep pockets [60].

Of note, emerging evidence suggests that there is a correlation between the severity of obesity and the progression of periodontitis and a relationship between the Metabolic Syndrome (MetS) and periodontal disease [71•]. This periodontal-systemic link has been consistent enough that some researchers have suggested that periodontal disease should be considered a component of MetS.<sup>6</sup> Accordingly, OHCPs are well positioned to identify patients who present with the appearance of central adiposity, as many of these individuals may have MetS which has not been diagnosed [71•]. An apple-shaped physique often denotes visceral fat distribution, a sign of MetS.

Patients who present with the classic signs and symptoms of diabetes (i.e., increased thirst and/or dry mouth, increased hunger, unexplained fatigue, increased urination, unexpected weight loss, blurred vision, and sores that do not heal) should be referred to a physician as soon as possible. However, there are patients who have diabetes who do not yet manifest these classic signs and symptoms. The ADA publishes criteria for identifying these asymptomatic adults (Table 2) [16••]. According to these criteria, if a patient is overweight and has these additional risk factors, he/she should be tested for diabetes.

<sup>6</sup> There are five definitions of MetS which include different criteria from the WHO report, the European Group for the Study of Insulin Resistance (EGIR), the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, the Adult Treatment Panel III (ATPIII), the Heart Association/National Heart, Lung, and Blood Institute Scientific Statement (AHA/NHLBI), and the International Diabetes Federation (IDF). Metabolic Syndrome Criteria as defined by the ATPIII include elevated central obesity as measured in waist circumference, low HDL cholesterol, elevated blood pressure, elevated triglycerides, and elevated fasting plasma glucose.



**Table 2** Criteria for testing for type 2 diabetes or prediabetes in asymptomatic adults

Testing for diabetes should begin at age 45. Risk factors that suggest a patient should be tested for type 2 diabetes:

- Overweight (BMI  $\geq 25$  or  $\geq 23$  kg/m<sup>2</sup> in Asian Americans)
- Physical inactivity
- First-degree relative with diabetes
- Members of a high-risk ethnic population (e.g., African American, Latino, Native American, Asian American, Pacific Islander)
- Women who delivered a baby weighing >9 lb or were diagnosed with GDM
- Hypertension ( $\geq 140/90$  mmHg or on therapy for hypertension)
- HDL cholesterol level <35 mg/dl (0.90 mmol/l) and/or a triglyceride level >250 mg/dl (2.82 mmol/l)
- Women with polycystic ovary syndrome (PCOS)
- A1c  $\geq 5.7$  %, IGT, or IFG on previous testing
- Other clinical conditions associated with insulin resistance (e.g., severe obesity, acanthosis nigricans)
- History of CVD

### Category 5: Patients with Prediabetes

Various periodontal parameters may be sensitive enough to identify people who may have prediabetes. Patients with poorly controlled prediabetes (FBPG of 100–125 mg/dL) may be more susceptible to periodontal destruction (i.e., increased BOP, PD, attachment loss [AL], and marginal bone loss) [72]. This evidence suggests that OHCPs should be vigilant in recognizing changes in the periodontium.

Herman and colleagues estimated that 30 % of patient who are 30 years or older may have prediabetes, many of whom see OHCPs on a routine basis—an opportunity to screen patients [13]. Researchers demonstrated that a one-page questionnaire that queried patients about gender, history of

hypertension, history of dyslipidemia, history of lost teeth, and either self-reported body mass index  $\geq 35$  kg/m<sup>2</sup>, with or without performing a finger stick to quantify random capillary glucose, can identify patients with prediabetes.

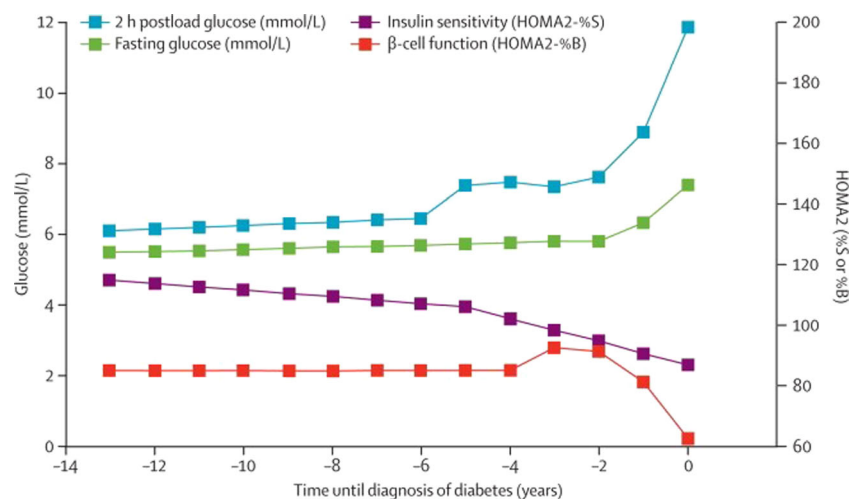
Recently, investigators discovered that gingival crevicular fluid (GCF) may be a source for screening blood glucose during routine periodontal examination in populations with an unknown history of diabetes mellitus [73]. Although the technique is safe and comfortable for the patient, investigators reported that obtaining blood samples from GCF is technique-sensitive which may impair adoption into everyday practice. Recently, researchers reported that blood obtained during probing of a periodontal pocket probing may be a reliable way to screen for diabetes in periodontal disease population [74].

There is a plethora of evidence to substantiate that early intervention by recommending lifestyle modification reduces progression from prediabetes to diabetes [17•]. During insulin resistance and prediabetes, there usually are no symptoms. People often have these conditions for years without being aware they have them. By identifying patients who have prediabetes, OHCPs can intervene with patient education targeting lifestyle modification that may avert or delay the onset of diabetes.

### Future Direction: Moving to Risk-Prediction Models That Provide for the Earliest Identification of Dental Patients Who Have Dysglycemia

We must recognize that intervening after people develop diabetes is too late. In people who develop diabetes, glucose levels and insulin secretion are higher and insulin sensitivity

**Fig. 1** Glucose, insulin sensitivity, and beta-cell function trajectories before the diagnosis of diabetes demonstrate an abrupt increase in glucose occurs as much as 3–6 years before diabetes is diagnosed. This provides a unique opportunity for OHCPs to identify patients with dysglycemia, even before prediabetes, when lifestyle modification has the greatest potential for averting diabetes [76] (used by permission of Elsevier)



lower than those without diabetes, as early as 13 years before diagnosis of diabetes [75, 76]. The risk of developing diabetes and related macrovascular complications may already be present at glucose concentrations below the cutoff values that define prediabetes [75]. By the time diabetes is diagnosed, beta-cell function may have declined substantially and the body damaged from prolonged hyperglycemia. Accordingly, focus on the prevention of type 2 diabetes should target the identification of people who are in the earliest stages of dysglycemia, even before prediabetes. Identifying patients in the earliest stages of dysglycemia allows for the earliest possible intervention. To delay intervention forfeits the opportunity to interrupt the progression to prediabetes, when the potential for prevention is greater.

In their Whitehall II study, Tabák and colleagues demonstrated trajectories of glycaemia, insulin sensitivity, and insulin secretion and proposed that people with prediabetes are often already on the “steep part of the glucose trajectory” [75, 76]. This is a period when there is transient instability of glucose metabolism with a rapid rise of glucose which often precipitates overt diabetes (Fig. 1). The onset of diabetes might be substantially deferred if HCPs intervene before this period of glucose instability (i.e., before people have prediabetes). Research is fairly conclusive that this abrupt increase in glucose occurs as much as 3–6 years before diabetes is diagnosed [77–79]. Accordingly, the greatest promise in preventing diabetes is identifying people who are insulin resistant or have some disturbance of glycemic metabolism (e.g., IFG, or IGT), before escalation to prediabetes or diabetes. OHCPs have a unique opportunity to intervene in the continuum associated with the development of diabetes. Future research should inform risk-prediction models that assist OHCPs in the earliest identification of dental patients who have dysglycemia, even before the prediabetes state.

## Conclusion

By virtue of the threat that impaired glucose metabolism poses to an array of oral and systemic diseases, more notably diabetes and periodontitis, OHCPs must be educated and trained to provide more comprehensive services to people who have diabetes, prediabetes, and/or periodontitis. Evidence gathered to date provides the justification for categorizing patients who have diabetes that has not been diagnosed with or without periodontal disease, dental patients who have periodontitis who are at risk for diabetes, and dental patients with prediabetes. By stratifying dental patients in these risk groups, OHCPs can be more effective in individualizing patient care, potentiating more optimal clinical outcomes. These are cases that will benefit from dental-medical collaboration and more patient-centric treatment planning and preventive protocols. Future research in support of a risk-prediction model that

provides for the earliest identification of dental patients who have dysglycemia will provide the framework for OHCPs to intervene with patient education that suggests lifestyle modification that may avert or delay the onset of diabetes. These measures will help curb the epidemic of diabetes and substantially enhance the role of OHCPs on the diabetes care team.

## Compliance with Ethical Standards

**Conflict of Interest** Casey Hein declares that she has no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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