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Clinical considerations for oral health in individuals with type 1 diabetes mellitus

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Abstract

People with type 1 diabetes are at increased risk of oral pathologies, particularly gingivitis and periodontal disease, even in the era of modern insulin delivery and apparently adequate metabolic control. This risk likely reflects the combined effects of hyperglycaemia-related changes in saliva and vasculature and early, subtle alterations in the oral microenvironment, including the microbiome and metabolome. Routine screening for oral symptoms and timely dental evaluation should therefore be incorporated into diabetes care, alongside clear patient education on daily oral hygiene and the importance of regular dental visits. Implementing these measures requires close collaboration between diabetology teams and dental professionals, including training diabetes nurses to deliver basic oral health counseling and facilitate referrals. Finally, further high-quality, multi-omic studies across oral niches are needed to define early biomarkers and develop evidence-based, diabetes-specific recommendations for prevention and management.

Keywords

type 1 diabetes, oral health, caries, periodontal diseases, gingivitis, continuous subcutaneous insulin infusion, gingival crevicular fluid, microbiome, metabolome

Oral pathology in diabetes

Diabetes increases the risk of multiple local abnormalities in the oral cavity (Table 1). This applies to both people with type 1 (T1D) and type 2 diabetes (T2D) [Mauri-Obradors 2017], although most research in type 1 diabetes has focused on diverse diabetes populations or individuals with uncontrolled hyperglycaemia.

The level of hyperglycaemia impacts the prevalence and severity of oral pathologies in people with diabetes, including periodontal disease (PD) [Dicembrini 2020]. Little is known about the risk of oral pathology in people with T1D who are intensively treated, i. e., with continuous subcutaneous insulin infusion (CSII) using an insulin pump or automatic insulin delivery (AID) systems. Recent research suggests that, despite adequate metabolic control sustained through these modern therapies, the prevalence of PD, especially its milder form of gingivitis, is higher in people with T1D than in those without diabetes [Gregorczyk-Maga 2023].

Mechanisms of oral pathology in diabetes

Multiple mechanisms increase the risk of oral pathologies in diabetes. These mechanisms involve quantitative and quali-

tative changes in saliva, the formation of advanced glycosylation end products and their deposition in tissues, hyperglycaemia-related vascular dysfunction, and nerve damage [Mauri-Obradors 2017, Dicembrini 2020].

PD, among many, is a microbiome disease, resulting at least partially from disturbances in its composition [Siddiqui 2023]. As diabetes has been shown to affect the oral microbiome, it is named as

one of the mechanisms underlying the increased risk of PD in this population [Quin 2022]. The relationship between the oral microbiome and the host is bidirectional: systemic diseases can alter microbial composition and

function, while microorganisms can, in turn, influence disease susceptibility, progression, and prognosis. Diabetes is one condition in which this interplay is particularly evident [Bourgeois 2019, Shaalan 2022]. People with PD and diabetes show a higher risk of uncontrolled hyperglycaemia, and, in parallel, individuals with higher HbA_{1c} show a higher risk of developing PD [Ranbhise 2025]. Furthermore, diabetic neuropathy may, unexpectedly, cause hypo- or hyperesthesia with the oral cavity, increasing the risk of oral lesion and their delayed diagnosis [Lipták 2026].

Alterations in the oral microbiome have been investigated mostly in people with

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Tab. 1: Oral pathologies in people with diabetes [Mauri-Obradors 2017].

- taste disturbance
- xerostomia
- mucosal lesions
- hypo- or hyperesthesia
- candidiasis
- periapical lesions
- dental caries
- periodontal disease (PD)
- tooth loss

T2D or individuals with T1D and poor metabolic control, with poor oral health, caries, or advanced periodontal lesions [van Heck 2022, Jensen 2021]. It is hypothesised that early changes in the oral microbiome composition, even in metabolically well controlled people with T1D, may predispose them to the development of PD. One study in children with metabolically stable T1D revealed slight shifts in the bacterial diversity [Stewart 2017]. In a recent study by Gregorczyk-Maga et al. of adults with T1D treated with CSII and with good metabolic control, no significant differences in the gingival crevicular fluid (GCF) microbiome were observed, with no taxa distinguishing people with T1D from non-diabetic controls [Gregorczyk-Maga 2023]. This study, however, identified early changes in the GCF metabolome [Gregorczyk-Maga 2023]. Altered metabolite concentrations may serve as indicators of oral cavity acidification, which may act as an additional predisposing factor for caries and PD [Kunath 2022]. Interestingly, these early changes may be caused by a poor-quality diet and excess body weight. Another study by Kania et al. found that the diet itself did not affect the GCF microbiome. It did, however, impact the GCF metabolome, suggesting an indirect association between diet and its contents on the health of periodontal tissues [Kania 2025].

Still, it remains unclear how the altered metabolome, possibly due to diet, paves the path for the development of a pathological microbiome, the pathogenic bacteria produce metabolites that lead to tissue damage, or both. More research is needed, including a multi-omic approach and investigation of other oral niches, such as saliva, dental plaque, and subgingival plaque, to understand the continuum of periodontal abnormalities in people with T1D.

Novel methods in the investigation of oral pathology in people with diabetes

Omics-based approaches, including metabolomics, transcriptomics, proteomics, and metabolomics, enable a comprehensive assessment of biological systems by identifying differences between healthy and diseased individuals and elucidating the mechanisms that underlie these changes [Aguilar-Pulido 2016]. Metabolomics can be applied to multiple sample types (e. g., stool, saliva, and GCF) and has been used to investigate a range of conditions, including diabetes and PD [Kc 2020]. However, the functions of many metabolites across body sites – including the gut, respiratory and genitourinary tracts, and the oral cavity – remain incompletely understood. Notably, the same metabolite may exert different, even opposing, effects depending on its concentration and anatomical context [Magrin 2020]. In addition, diet-derived metabolites can shape microbiome composition, while many of the same compounds are also synthesised by bacteria, reflecting complex bidirectional host–microbe interactions [Magrin 2020]. Additionally, the interplay between different oral niches, including tooth surfaces, gingiva, gingival sulci, and mucosal surfaces, and their microbiome, is not fully understood [DeWhirst 2010]. Its investigation as a whole may help clarify the complex interactions in health and disease states.

Screening for oral pathology in people with T1D and oral care recommendations

A review suggests that people with diabetes generally have limited oral health knowledge, less positive attitudes toward oral care, and suboptimal behaviors, including infrequent dental visits [Poudel 2018, Banyai 2022]. Even though it is well established that diabetes increases the risk of oral pathology, people with diabetes also rarely receive oral health education or dental referrals from diabetes care providers. To the contrary, when diabetes clinicians provide oral health education and refer patients to dental services as needed, patients' oral health behaviors improve [Poudel 2018, Banyai 2022], making trained diabetes team members potential core messengers. For in-

stance, diabetes nurses should receive oral health training delivered in partnership with dentists or dental hygienists [Banyai 2022]. As poor quality diet and poor nutritional status, including excess weight, were reported to be associated with a higher risk of PD, a proper dietary education and interventions aimed at avoiding body weight gain may be treated as additional prophylactic measures against PDs.

Overall, the findings highlight the need for targeted patient education and motivation, as well as improved access to dental care and referral pathways.

Screening for early signs of oral pathology in people with T1D may take place both in the diabetologist's, endocrinologist's, or dentist's office. It would be advisable to utilise validated questionnaires, such as Oral Health Impact Profile (OHIP-14) questionnaire or even a simpler questionnaire that included questions regarding:

- higher viscosity of saliva
- xerostomia
- bleeding – either spontaneous or while brushing
- hypo- or hyperesthesia
- taste prescription
- tendency towards poor healing of oral mucosal lesions
- pain, burning, and white lesions within the oral cavity
- bad breath
- food selectiveness

Nevertheless, there is a paucity of high-quality data to support evidence-based recommendations for oral health care in people with diabetes, regardless of type. Thus, the American Diabetes Association (ADA) includes only a few points, mainly based on the recommendations for the general population (Table 2) [ADA].

Tab. 2: Oral care recommendations in people with diabetes according to the American Diabetes Association [ADA].

- brushing for two minutes, twice a day, with a fluoride toothpaste
- flossing or using an interdental device once a day
- dental appointment min. twice a year (due to the high prevalence of gum disease in people with diabetes, more frequent appointments every 3 months with cleaning may be recommended)

Conclusion

People with T1D are at increased risk of oral pathologies, particularly gingivitis and periodontal disease, even in the era of modern insulin delivery and apparently adequate metabolic control. This risk likely reflects the combined effects of hyperglycaemia-related changes in saliva and the vasculature, as well as early, subtle alterations in the oral microenvironment, including the microbiome and metabolome. Routine screening for oral symptoms and timely dental evaluation should therefore be incorporated into diabetes care, alongside clear patient education on daily oral hygiene and the importance of regular dental visits. Implementing these measures requires close collaboration between diabetology teams and dental professionals, including training diabetes nurses to deliver basic oral health counseling and facilitate referrals. Finally, further high-quality, multi-omic studies across oral niches are needed to define early biomarkers and develop evidence-based, diabetes-specific recommendations for prevention and management.

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Conflicts of interest

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CORRECTION · CORRECTION · CORRECTION

Corrigendum to CEDA Abstracts (Diabetes, Metabolism, and the Heart 2026, issue 3, p. 159 – 180)

In the abstract A05 entitled „A 3-month course of multispecies probiotic supplementation enhances insulin sensitivity, lipid profile, inflammation and symptoms in young adults with early metabolic risk” from Mohamed Elayess and co-authors, the authors regret that an error occurred in the acknowledgement. The following information was missing: „This work is funded by the Qatar Research, Development and Innovation Council (QRDI) under grant number ARG1 0420 230007.”