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Periodontal disease
in children with type 2 diabetes mellitus

Abstract: Collaborative efforts between health team members can advance early detection of children with elevated blood glucose levels, preventing hyperglycemia and periodontal diseases. Rates of obesity are increasing in children, impacting the prevalence of type 2 diabetes mellitus and periodontal diseases. Collaborative care between nurse practitioners and dental hygienists can detect, prevent, and treat periodontal disease in children.

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The incidence of diabetes mellitus in children began increasing 20 years ago.[1] Approximately 8.3% of the U.S. population has diabetes, with nearly 19,000 cases of type 2 diabetes mellitus (T2DM) in children and adolescents.[1,2] The World Health Organization estimates 90% of individuals with diabetes have T2DM.[1] Between 2001 and 2009, researchers from the SEARCH for Diabetes in Youth study found that T2DM in children and adolescents ages 10 to 19 years had increased 21%.[2,3]

The prevalence of type 1 and T2DM (predominantly T2DM) is predicted to increase by 54% to over 54 million individuals by 2030.[1,2,4] Reducing the incidence of T2DM may improve the health of children and adolescents, and delayed screening can result in a missed opportunity to impact their health.[2]

This article highlights the importance of collaborative care between NPs and dental hygienists in the detection, prevention, and treatment of periodontal disease in children with T2DM. It focuses on the reciprocal relationship between T2DM and periodontitis and the importance of early intervention and interprofessional teams achieving the goals established for Healthy People 2020. The relationship between T2DM and periodontitis in children has not been extensively discussed in the literature.

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Keywords: children, collaboration, interprofessional teams, obesity, periodontal disease, periodontitis, T2DM, type 2 diabetes mellitus

Dental hygiene and T2DM

Multiple published studies describe the reciprocal relationship between diabetes mellitus and periodontal disease.[5-7] It is well established that poor oral health can lead to adverse health outcomes.[8] Current data suggest periodontal disease may occur in the tissues from inflammation as a result of elevated blood glucose levels.[6] A higher incidence of periodontal disease in children with poorly controlled blood glucose levels can also result in a negative health outcomes.[7-9]

In a hallmark study by Löe in 1993, periodontal disease was linked to hyperglycemia in patients with diabetes.[10] Periodontitis could be regarded as the sixth complication of diabetes. Löe established a reciprocal relationship between diabetes and periodontal disease.[10] This study linked the importance of oral health in patients with diabetes.[5,10] Children and adolescents with diabetes have an increased incidence for and earlier onset of gingivitis, which if left untreated, may be a precursor to periodontitis.[10] Current evidence suggests periodontal disease adversely affects health outcomes for children with T2DM.[6,7]

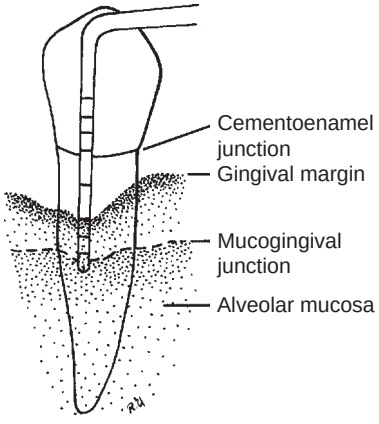
According to the CDC, over 19% of children ages 2 to 19 years have untreated tooth decay and dental caries, making it the most common chronic disease of childhood.[11] Healthy People 2020 has screening and referral programs aimed at health promotion and disease prevention.[2] Because of this focus on improving oral health for children, primary care providers (PCPs) are integrating pediatric oral exams, including dental screenings, into well-child exams.[2] Medicaid is now reimbursing PCPs for dental screenings integrated into well-child exams.[12]

Due to the complexities of T2DM, it is important to develop a collaborative approach between healthcare providers to assure early diagnosis and to prevent complications from this multifactorial illness. Periodontitis is more prevalent and severe in children with T2DM than children without diabetes.[6] Individuals with a hemoglobin A1C (A1C) over 7% were associated with a significant increase in gingival inflammation compared with individuals without diabetes after controlling for oral hygiene levels.[13]

Chronic inflammation is identified as one of the key factors connecting T2DM and periodontitis.[5,7] A knowledge gap exists between disciplines regarding the correlations between oral health, T2DM, and health outcomes. As evidence continues to be compiled, the relationship between oral health and T2DM in children will become clear, and misconceptions can then be eliminated. Interprofessional teams working together can advance the knowledge of this complex health issue, eliminating practice silos and improving health outcomes by engaging in collaborative practice.

CEJ

The image below shows the relationship of the gingival margin to the cementoenamel and mucogingival junctions.



Source: *Lippincott Williams & Wilkins' Comprehensive Dental Assisting.* Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2012.

Progression of gingivitis to periodontitis

Gingivitis is the first stage of periodontal disease and is defined as an inflammation of the gingival tissues, with no apical migration of the junctional epithelium beyond the cementoenamel junction (CEJ).[13] (See *CEJ*.) The CEJ is defined as the areas of union of the cementum and enamel at the cervical region of the tooth.[14] Gingivitis is characterized by inflammation and swelling of the gingival tissues with bleeding upon probing.[13] Periodontitis is a bacterial inflammatory disease of the supporting tissues and structures of the teeth, including gingiva, periodontal ligament, cementum, and alveolar bone.[15] Gingivitis is associated with inflammation, and if left untreated, progresses to periodontitis.[15] (See *Gingivitis*.) Periodontitis manifests as the destruction of gum tissue and ultimately bone loss.[13,15]

The term *gingivitis* signifies the inflammation of the gingiva, the gum area that surrounds the teeth, which becomes red and edematous.[13,15] This condition can progress to periodontal disease, causing destruction of the structures surrounding the tooth, including the alveolar bone (which supports the teeth in their sockets).[13,15] Both gingivitis and periodontitis can occur in children; however, gingivitis is more frequently documented and occurs in children as young as age 5 years.[15] Diabetes mellitus is a risk factor for periodontal disease and is significantly aggravated in patients who have poor control of their blood glucose levels or long-term hyperglycemia.[5,7,16] Hyperglycemia is diagnosed when a fasting blood glucose level reaches 126 mg/dL or higher.[17]

A two-way bidirectional relationship exists between the degree of hyperglycemia and the severity of periodontal disease, with diabetes increasing the risk of periodontitis, and periodontal inflammation negatively affecting glycemic control.[7] Patients diagnosed with T2DM are 2.6 to 4 times more likely to eventually develop periodontal disease and 15 times more likely to become edentulous than patients who do not have diabetes.[5] Hyperglycemia contributes to the deterioration of periodontal tissue without regard to the etiology or type of diabetes mellitus.[18] This breakdown of tissue triggers an inflammatory reaction.

Proinflammatory cytokines triggered by the inflammatory process in periodontal disease play a key role in regulatory responses, including disruption in the insulin level.[19] When the cytokines are secreted inappropriately, it results in periodontal pathology.[19] This balance between proinflammatory and anti-inflammatory processes is crucial in the development of periodontal disease.[19] Poorly controlled T2DM (elevated A1C levels) contributes to periodontal disease. In contrast, well-controlled T2DM does not increase the incidence of periodontal disease.[15,16,18]

To effectively combat the effects of both chronic illnesses, NPs and dental hygienists need to work collaboratively and have a comprehensive understanding of oral inflammation due to long-standing hyperglycemia. Studies have shown if gingivitis is undetected or untreated, it will progress to periodontal disease.[5,16] Given the potential for poor health outcomes, a collaborative effort is needed to control complications and prevent periodontal disease in children with diabetes mellitus.[9] Additional oral problems in children with diabetes include dental caries, oral mucosal lesions, xerostomia, tooth loss, and fungal infections.[15]

The role of the NP is to understand the link between hyperglycemia and gingivitis in order to halt disease progression.[5] Gingivitis or periodontal disease may be detected and prevented by performing early oral screenings during well-child visits.[2,12] Chronic gum inflammation in children can cause a heightened inflammatory response, resulting in hyperglycemia, which precedes the onset of diabetes mellitus.[15] Health screening outcomes should be communicated to team members, and an interdisciplinary care plan should be developed and implemented in the clinical setting. A focused screening should include a detailed head and neck exam, including the oral cavity.

The physical exam

During routine screenings or well-child visits, the NP screens for signs and symptoms of disease processes, including performing an oral exam. NPs inspect the mouth, including the teeth and gums, for abnormalities. Hyperinsulinemia, the precursor to T2DM, changes the bacterial flora in the oral cavity, making the patient more prone to dental caries, gingivitis, periodontal disease, and tooth loss.[5]

Although radiographs provide ultimate confirmation of oral disease processes, observation and review of the oral cavity are essential components of a standard physical assessment to note any suspicious areas of concern. The number of missing teeth and dental caries are noted, including any signs of inflammation. For example, numerous studies have shown patients with diabetes have a higher incidence of dental caries due to hyperinsulinemia.[6,11,13]

Xerostomia

There is compelling evidence that changes in the oral cavity are associated with poor health outcomes.[20,21] Patients with diabetes have a higher incidence of hyposalivation, or xerostomia.[20] Salivary flow declines in diabetes, causing xerostomia. Hyposalivation results in a lower salivary pH, reducing immune defenses in the oral cavity.[21]

A reduction in saliva causes the tooth enamel to undergo hypomineralization, which can lead to the formation of dental caries.[20] Early identification of hyperinsulinemia may prevent oral complications, including excessive enamel wearing and hypomineralization.[20] Poor metabolic control in diabetes is associated with a higher risk of gingivitis, periodontitis, and tooth loss.[20] Often, early changes in the mouth precede a diagnosis of hyperinsulinemia, making xerostomia an early marker of T2DM.[20]

Gingivitis

The photo to the left shows the tissue margin in gingivitis, the mildest form of periodontal disease. Gingivitis is characterized by inflammation and swelling of the gingival tissue. There is no destruction of periodontal ligament fibers or alveolar bone in gingivitis.

Source: Gehrig JS, Willmann DE. *Foundations of Periodontics for the Dental Hygienist.* 4th ed. Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2015.

Oral fungal infections

Fungal infections, including oral candidiasis or thrush, can be detected during the oral exam. NPs can detect white patchy areas on the gums and oral mucosa of the mouth. Patients often complain of their mouth feeling sore or tender, especially when swallowing. Oral candidiasis is common during periods of hyperinsulinemia or poor blood glucose control.[22] An increase in the blood glucose level promotes a change in the oral flora, providing food for *Candida*, which can cause an increase in the growth of yeast.[22]

A dry mouth also encourages the growth of yeast, especially when coupled with hyperinsulinemia. Saliva can alter flora in the mouth by neutralizing acidic foods and drinks to protect teeth and soft oral tissues; saliva also acts a buffering system to neutralize acid.[20] Lower levels of saliva cause changes in the biofilm and protect the teeth and oral tissues.[23,24] When the organisms within the biofilm undergo changes, the result is inflammation of supporting tissues, which results in gingivitis.[23] These findings suggest patients with poorly controlled diabetes tend to be immunologically comprised due to changes in their ability to keep the body's regulatory systems intact and fully functioning.

Skin changes

Skin changes are prevalent in patients with hyperinsulinemia, including acanthosis nigricans, fungal infections, skin tags, and xanthomatosis.[25] Acanthosis nigricans, a precursor to T2DM, consists of tan or brown raised patches of thickened skin, has a velvety appearance, and is usually located in the neck, armpit, and/or groin area.[25] The discoloration can also appear on flexor areas, such as the hands, elbows, and knees. Acanthosis nigricans is more common in overweight or obese children, indicating an insulin sensitivity problem.[25]

Early warning signs of impaired glucose tolerance and insulin resistance include subtle skin changes such as skin tags and xanthomatosis.[26] Skin tags are flesh-colored projections that can be detected on the neck and upper chest area; although benign, they are easily detected during a skin exam. Xanthomatosis are yellow, pea-like enlargements under the skin caused by abnormal storage of fat resulting from lipid metabolism and formation of foam cells.[26] They are usually found on the knees and elbows but may occur on any of the tendons. NPs can detect subtle skin changes that are associated with impaired glucose tolerance and insulin resistance while performing a routine physical exam. By identifying these skin changes, as well as identifying abnormalities during the oral exam, NPs can provide early interventions to help halt the progression of T2DM and periodontal disease.

Innovative approaches to screening

A relationship between periodontal diseases and diabetes has been established. One cross-sectional study suggests bleeding on periodontal probing is more often found in participants with impaired fasting glucose or prediabetes.[23] Periodontal probing is routinely completed by a dental hygienist and any bleeding found during the probing process could be used as a source of blood for estimating blood glucose levels simply by transferring the sample to a portable glucose monitor.[13] This gingival crevicular blood (GCB) sample has been investigated as a reliable source for screening and is comparable to capillary finger sticks.[13]

As an example, Gaikwad and colleagues' study results demonstrated statistical significance ($P < 0.0001$) in using GCB for screening of patients during dental exams.[27] In the presence of gingivitis in children and adolescents, periodontal probing should be considered as an additional method of collecting blood for the sample.[23] By including assessment of children and adolescents, the dental hygienist can assist in early recognition of T2DM.

Forming collegial relationships with dental practices, NPs will refer children with T2DM for early screening and evaluation. Detecting skin changes and oral lesions is within the dental hygienist's scope of practice. Dental hygienists can screen for acanthosis nigricans, skin tags, candidiasis, and/or gingivitis as early indicators of glucose intolerance, impaired fasting glucose, or undiagnosed T2DM.[28] By measuring glucose levels during routine dental probing, this population has an additional avenue for early diagnosis and treatment of diabetes.[27] This collaboration could revolutionize healthcare coordination, resulting in better health outcomes in multiple environments.

Diagnostic criteria

The American Diabetes Association (ADA) provides recommendations to diagnose children who meet the criteria for diabetes screening (see *Reference guides for T2DM screening in children and adolescents*).[29] The ADA recognizes that an A1C test can be performed on children and adolescents; however, it cannot be used as the only criteria for diagnosis.[29] Obese children should receive more comprehensive screening, including evaluation for additional risk factors. The ADA recommends diagnostic assessment every 3 years when patients present with two or more of these risk factors:

- a first- or second-degree family history of T2DM
- race and ethnicity (Native American, Black American, Hispanic, Asian American, and Pacific Islander)
- signs of insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome, small for gestational-age birth weight)
- born to a mother with gestational diabetes.[29]

Reference guides for T2DM screening in children and adolescents

Item	Description	URL
Body mass index (BMI)	This calculator provides BMI and the corresponding BMI for age percentile on a CDC BMI for age growth chart. Use this calculator for children and adolescents ages 2 through 19 years.	https://nccd.cdc.gov/dnpabmi/Calculator.aspx
BMI percentage curve charts	BMI calculations for children and adolescents are expressed as a percentile relative to other children in the United States because weight and height change during growth and development. Therefore, a child's BMI must be interpreted relative to other children of the same gender and age.	Boys ages 2 to 20 years www.cdc.gov/growthcharts/data/set1clinical/cj41l023.pdf Girls ages 2 to 20 years www.cdc.gov/growthcharts/data/set1clinical/cj41l024.pdf
Age-based pediatric BP reference charts	This calculator compares findings to healthy BP and automatically adjusts for height, age, and gender, calculating the child's height percentile along with BP percentile.	www.bcm.edu/bodycomplab/Flashapps/BPVAgeChartpage.html

Collaborative practice implications

Collaborative practice includes the active participation of different disciplines in providing patient care. This is especially important in the care of children with a preventable illness, such as T2DM. The challenge is to create an environment promoting active engagement and good communication among NPs and dental hygienists. Healthcare providers can create a shared vision of reporting signs or symptoms of early disease processes across disciplines to decrease health disparities and improve health outcomes.

Working together, multiple disciplines can establish practice protocols defining roles and action plans. Effective interprofessional collaboration enhances participation in clinical decision-making. Collaboration between endocrinologists, dentists, dental hygienists, NPs, and other healthcare professionals, including certified diabetes educators, can result in earlier diagnosis and quicker entry into the healthcare system. Teams should focus on meeting Healthy People 2020 goals, including starting preventive health services and dental screenings at an early age, to improve oral health.

Conclusion

The incidence of T2DM will increase as the number of overweight and obese children rises. Regardless of age, glucose excursions and intolerance may remain undetected for several years prior to the official diagnosis of diabetes. Combined collaboration has the ability to advance early detection of patients with elevated glucose levels and prevent the complications associated with uncontrolled diabetes. Early diagnosis has a significant impact on long-term health outcomes in children and adolescents.[9] Interprofessional collaboration provides a unique opportunity for improving the health of children and adolescents.

Interprofessional collaboration between an NP and dental hygienist provides a distinct opportunity and may mitigate or minimize negative health outcomes. In January 2017, Kaiser Permanente opened a privately funded, integrated medical-dental clinic in Beaverton, Oregon.[30] This is the first Kaiser clinic to offer both primary care and dental care in the same building, with staff collaborating to provide integrated care. It is hoped this trend will continue to be implemented across disciplines and the nation.[30]

Healthcare systems are changing, and innovation is needed, as the growing number of children with T2DM continues to rise. This vision of interdisciplinary teams is intended to improve the care of children. Assembling an interdisciplinary team alleviates the silo effect created by practicing within one's own discipline, resulting in a more effective resource than the two disciplines could achieve individually. NP

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Periodontal disease in children with type 2 diabetes mellitus

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