Scientific Article

Gingival Bleeding in 6- to 13-Year-Old Children with Diabetes Mellitus

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Abstract: ***Purpose:*** *This study assessed gingival bleeding in diabetic children during the mixed dentition period.* ***Methods:*** *Three hundred fifty-five 6- to 13-year-old diabetic (99% type 1) and nondiabetic control children in the mixed dentition stage were evaluated from a total cohort of 700 6- to 18-year-old children. Gingival status was assessed, and data on important diabetes-related variables were collected. Analyses were performed using Poisson's regression.* ***Results:*** *Diabetic children had significantly more gingival bleeding than controls for both primary and permanent teeth. The risk of gingival bleeding around the primary teeth in cases was 35% more than in the control group (P=.001); and the risk of gingival bleeding around the permanent teeth in cases was 57% more than in the controls (P<.001). The number of teeth with bleeding had a very modest, but statistically significant, association with: (1) mean HbA1c; (2) body mass index (BMI)-for-age percentile; and (3) duration of diabetes.* ***Conclusions:*** *These findings demonstrate that diabetic children are at a significantly higher risk for gingival bleeding. Diabetes-related oral complications affect the primary periodontium as early as age 6 and possibly earlier. The emphasis on oral hygiene may be valuable in preventing future periodontal complications in diabetic patients. (Pediatr Dent 2007;29:426-30) Received November 3, 2006 / Revision Accepted January 14, 2007.*

KEYWORDS: CHILDREN, DIABETES, GINGIVAL BLEEDING, PLAQUE INDEX, PRIMARY TEETH

Diabetes mellitus is marked by elevations in the glucose concentration in the blood secondary to: (1) insulin deficiency; (2) insulin resistance; or (3) both.[1] This leads to a variety of pathological processes, including the nonenzymatic binding of sugar molecules to blood proteins. As a consequence, diabetic individuals may develop complications that arise primarily from hyperglycemia-associated biological alterations.[2]

Gingivitis and periodontitis, 2 forms of periodontal disease, are well recognized oral complications of diabetes mellitus.[2-4] This association, although well established in adults, was highlighted in a recent study of 6- to 18-year-old children.[5] The findings clearly indicate that periodontal destruction is increased in diabetic children and adolescents and manifests earlier in life than previously recognized. The study, however, reported data on gingival inflammation and attachment loss for permanent teeth only.

Studies investigating gingival inflammation in the primary and mixed dentitions of diabetic children are rare.[6] The largest known study (N=77) in the literature found that diabetic children who had poor metabolic control showed a clear tendency toward higher gingival index scores than healthy children.[7] This study did not distinguish between primary and permanent teeth. Ringelberg et al[8] and Bernick et al[9] also found a higher degree of gingivitis in diabetic children. The plaque challenge was not assessed in the former study; neither study distinguished between gingival inflammation in the primary vs permanent teeth. To further investigate these differences, we chose to examine 6- to 13-year-old children. This period of dental transition offers an excellent opportunity to concurrently study intraindividual differences in gingival health at both the primary and permanent tooth sites. Also studied were associations between: (1) gingival bleeding; (2) mean hemoglobin A1c (**HbA1c**); (3) duration of diabetes; and (4) body mass index (**BMI**)-for-age percentile.

Methods

The study protocol was approved by the Institutional Review Board of the Columbia University Medical Center (**CUMC**),

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New York, NY. Study subjects/legal guardians/parents provided consent prior to participation.

Study population. This study's total cohort was 700 children ranging from 6 to 18 years old (350 diabetic cases and 350 healthy controls). Of this total, data from 355 6- to 13-year-old children in the mixed dentition stage were used for the present analyses. This sub-cohort consisted of:

a. 164 patients with diabetes mellitus examined at the Naomi Berrie Diabetes Center at CUMC; and
b. 191 nondiabetic control children belonging to the same age group examined at the Columbia University College of Dental Medicine.

Children in both groups were excluded if they were undergoing active orthodontic therapy.

Oral examination protocol. Participants and/or guardians responded to questions related to past medical and dental history. All dental measurements were performed by 1 of 3 calibrated examiners for teeth in 1 quadrant from each arch. The 2 quadrants were assigned by computer, alternating between quadrant numbers 1 and 3, 2 and 4.

The following were evaluated at 4 sites per tooth (mesiobuccal, distobuccal, mesiolingual, distolingual) for all nonexfoliating primary and fully erupted permanent teeth (third molars excluded), using a manual periodontal probe:

a. Plaque index (**PI**)—each site was given a score from 0 to 3, as described by Silness and Löe[10].
b. Gingival index (**GI**)—each site was given a score from 0 to 3, according to Löe and Silness.[10] In this index, a GI score of 2 or 3 denotes a bleeding site.

Diabetes-related variables. The following information was collected from medical records:

1. type of diabetes and duration (years since diagnosis);
2. insulin regimen (multiple daily insulin injections or continuous subcutaneous insulin infusion) and/or oral hypoglycemic medications;
3. HbA1c results over the 2-year period preceding inclusion into the study; and
4. BMI-for-age percentile (a measure of relative weight determined from the child's: (a) BMI (b) age and (c) gender.

Data and statistical analysis. The statistical analysis consists of 2 parts (the main response variable is the number of sites with bleeding [GI≥2]):

1. We compared bleeding about primary vs permanent teeth based on a Poisson regression model. The generalized estimating equation method was used to account for within-subject correlation. The case-control comparison was performed thereafter, again using a Poisson regression.
2. We studied the association of bleeding with diabetes-related variables such as: (a) mean HbA1c; (b) BMI-for-age percentile; and (c) duration of diabetes (squared root transformed for better fit) based on a Poisson regression model.

These analyses were controlled for the patient's: (1) age; (2) gender; (3) ethnicity (Hispanic vs non-Hispanic); (4) reported frequency of dental visits (log transformed for better fit); and (5) dental examiner.

All the statistical analyses were performed using SAS, v. 9.1 (SAS Institute, Cary, NC), and a *P*-value of .05 or less was viewed as statistically significant.

Results

The study population's demographic data and clinical periodontal parameters are presented in Table 1. The PI was comparable for the 2 groups (1.16 for cases vs 1.14 for controls; unadjusted $P=.65$). In both cases and controls, the PI was significantly higher in permanent teeth than in primary teeth ($P<.001$). Diabetic children had significantly more gingival bleeding than controls in both primary and permanent teeth. The diabetes-related variables for the case group are presented in Table 2. The vast majority of children examined had type 1 diabetes. The mean duration of disease was 3.1 years, and 10% of all case subjects had poor metabolic control (HbA1c>10%). The number of children with a BMI-for-age percentile greater than 85 (overweight and at-risk for overweight) was 61 (37%). As shown in Table 3, the risk of gingival bleeding for primary teeth in cases was 35% more than that for the controls ($P=.001$); the risk of gingival bleeding at permanent sites in cases was 57% more than that for the controls ($P<.001$).

Cases and controls had significantly more gingival bleeding around the permanent teeth than the primary teeth (relative risk (**RR**) of permanent vs primary=1.5, $P<.001$). Also, the case-control difference is similar when comparing bleeding in permanent or primary teeth ($P=.90$).

Finally, we analyzed the association between the number of primary bleeding sites and certain diabetes variables, namely: (1) HbA1c; (2) BMI-for-age percentile; and (3) diabetes duration. This was done within the case group using a fully adjusted Poisson regression model (data not shown). Although the associations reached statistical significance, the (RR) values were very close to 1 (the highest=1.20, with every 1 year of increase in disease duration), suggesting no clinical significance.

Table 1. DEMOGRAPHIC AND PERIODONTAL CHARACTERISTICS OF STUDY POPULATION (N=355)*

	Controls (Non-diabetic) N=191	Cases (Diabetic) N=164	*P*-value †
Age (years)	9.29 ± 1.64	8.35 ± 1.77	<.001
Gender: Female	99 (52)	88 (54)	.73
Ethnicity:			<.001
• **Hispanic**	155 (81)	48 (29)	
• **Non-Hispanic**	36 (19)	116(69	
Medical insurance (with coverage)	185 (97)	151 (92)	.046
Reported frequency of dental visits/year	1.57 ± 1.29	1.61 ± 0.71	.72
Reported age at first dental visit (years)	4.69 ± 2.11	3.56 ± 1.73	<.001
Plaque index:	1.14 ± 0.37	1.16 ± 0.35	.65
• **Of primary sites**	1.10 ± 0.42	1.05 ± 0.36	.30
• **Of permanent sites**	1.18 ± 0.37	1.25 ± 0.37	.085
Percentage of primary sites with bleeding	13 ± 20	14 ± 22	.95
Percentage of permanent sites with bleeding	12 ± 15	17 ± 19	.009

* Data shown as mean ± SD or N (%).

† Derived from unadjusted *t* tests and chi-square tests

Discussion

The prevalence of gingivitis is low in early childhood and dramatically increases with age. When a group of healthy preschool children withheld oral hygiene measures for 27 days, no increase in the degree of gingivitis occurred.[11] When adults participated in a similar experimental gingivitis study, gingival inflammation measures were significantly higher.[12] These conclusions have been confirmed in subsequent studies demonstrating that healthy preschool children with a plaque index 4 times that of adults had only one fourth the gingival index.[13,14]

Several reasons for the delayed development of gingivitis in the primary dentition have been proposed: (1) increased anabolism; (2) decreased leukocytic migratory rates; (3) differences in plaque composition; and (4) low levels of immunoglobulin specific for plaque bacteria.[15] More significantly, the vascular inflammatory response may be delayed in children. Such a response is reflected in the decreased amount of gingival exudate and bleeding found in this age group.[16] These "protective" influences, however, appear to be altered in diabetes mellitus. Diabetic children exhibit an increase in gingival exudate and bleeding compared to their systemically healthy counterparts.[7]

This study's findings indicate that diabetic children are at a 35% greater risk for gingival bleeding at primary teeth sites compared to nondiabetic children. Increased gingival bleeding was also seen in permanent teeth sites in cases with a higher risk of 57% as compared to controls. Although there were no case-control differences, the plaque index in permanent teeth was higher than in primary teeth within each group. Interestingly, bleeding was not significantly related to dental plaque, supporting the concept that hyperglycemia-associated biological alterations, which modify the host response toward plaque, were responsible.[17]

Gingival bleeding around primary teeth was also associated with bleeding in the permanent sites at the subject level. This was seen in both cases and controls. Even though this was a cross sectional study, it seems plausible to suggest that bleeding in the permanent dentition may have its origins in the primary dentition. If so, gingival bleeding in primary teeth may have some prognostic value for future risk of periodontal disease, especially in diabetic children.

Although not all gingivitis leads to destructive periodontal disease, diabetic children exhibit a higher propensity for periodontal destruction.[4] This is important, as periodontal diseases are largely preventable even in susceptible individuals and progression of destruction can be best arrested with timely identification of the disease. Moreover, emerging evidence indicates that treatment of periodontal infections in diabetic adults may have a positive effect on the level of metabolic control in these individuals.[18-20] Therefore, in light of present findings, oral screenings and preventive programs need to emphasize the importance of periodontal infections starting with the primary dentition, particularly in children and adolescents with diabetes mellitus.

Conclusions

Based on this study's results, the following conclusions can be made:

1. Children with diabetes mellitus exhibit significantly higher gingival bleeding in both primary and permanent tooth sites during the mixed dentition period.
2. Future studies need to focus on the primary dentition exclusively to better establish the origins of periodontal disease in healthy and medically compromised children.

Table 2. DIABETES-RELATED VARIABLES FOR THE CASE GROUP (N=164)*

Diabetes type:	**N=%**
• Type 1	162 (99)
• Type 2	2 (1)
Duration (ys)	3.10 ± 2.31
Treated with:	
Insulin only	163 (99)
Multiple daily injections	111 (68)
Continuous subcutaneous infusion	52 (32)
Oral hypoglycemic medication(s) only	0 (0)
Both	0 (0)
Mean HbA1c over past 2 years (%):	8.08±1.30
<8 %	53 (34)
8-10 %	88 (56)
>10 %	17 (10)
BMI-for-age percentile:	69.35±26.51
At risk/overweight (BMI ≥ 85)	61 (37)

* Data shown as mean ± SD or N (% total).

Table 3. ESTIMATED RELATIVE RISK OF BLEEDING FOR CASES (DIABETIC) OVER CONTROLS (NON-DIABETIC) FROM POISSON REGRESSION ANALYSIS*

Number of:	**Relative risk**	**95% confidence interval**	***P*-value**
Primary sites with bleeding	1.35	(1.12, 1.61)	.001
Permanent sites with bleeding	1.57	(1.35, 1.82)	<.001

* Adjusted for age, gender, ethnicity, plaque index, frequency of dental visits, and dental examiner.

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Abstract of Science of Literature

Tobacco advertising a predictor of smoking in young adulthood

This study assessed the effects of tobacco advertising in two groups of young adolescents followed for 6 years. Children in this study came from the 1993 and 1996 California Tobacco Surveys. They were 12 to 15 years old at the start of the study when they were interviewed about their behaviors and attitudes towards the use of tobacco. The children were contacted 6 years later to complete the follow-up interview. Receptivity to tobacco advertising was assessed in several ways, including asking whether youth 1) had ever bought or received a product that promotes or was distributed by a tobacco company, 2) would use a tobacco company promotional item (eg, T-shirt), and 3) could name the most frequently advertised cigarette brand. A total of 1734 respondents from the 1993 cohort and 1983 from the 1996 cohort completed this follow-up interview. Smoking status at the end of the study was not related to the age of children at baseline. Youth who were willing to use or had used a tobacco promotional item were nearly twice as likely to be an established smoker during young adulthood. Similarly, those who indicated they had a favorite ad for a tobacco product at baseline were also significantly more likely to be established smokers 6 years later. Youth who are more receptive to tobacco advertising are more at risk of becoming established smokers as young adults. Tobacco advertising has tremendous influence on the choices youth make on whether or not to smoke. ***Comments****: This study presented clear evidence that tobacco advertising and youth receptivity to such are associated with the commencement of smoking in youth. Dentists should be aware that tobacco advertising aimed at youth continues to have an influence on their future smoking habits. Considering the negative effects of tobacco on both general and oral health, the oral health community could assist with efforts to prevent the tobacco industry from targeting youth and should educate their patients of the harms associated with tobacco use.* ***RJS***

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64 references