Type 1 Diabetes Mellitus and Oral Health: Assessment of Periodontal Disease

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Background: The periodontal disease status of 320 dentate adults, diagnosed 23.7 years previously with Type 1 insulin dependent diabetes mellitus, was evaluated. These patients had been monitored at 2-year intervals as part of a large University of Pittsburgh longitudinal study assessing the medical complications associated with insulin dependent diabetes.

Methods: During one of their regularly scheduled medical examinations, a group of 320 adult dentate subjects (mean age of 32.1 years) received a periodontal examination as part of a comprehensive oral health assessment. The oral health assessment collected data regarding demographics, oral health behaviors, tooth loss, coronal and root caries, salivary functions, and soft tissue pathologies. For the periodontal assessments, 3 facial sites (mesial, mid-cervical, distal) of the teeth in the right maxillary/left mandibular or left maxillary/right mandibular quadrants were evaluated for calculus, bleeding on probing (BOP) and loss of gingival attachment (LOA).

Results: Attachment loss was significantly greater for older patients whereas BOP and calculus levels were relatively constant across age categories. Univariate analyses of factors possibly related to extensive periodontal disease (LOA ≥4 mm for at least 10% of sites examined) indicated an association with older age; lower income and education; past and current cigarette smoking; infrequent visits to the dentist; tooth brushing less than once per day; older age of onset; longer duration of diabetes; and the diabetic complication of neuropathy. A multivariate regression model of all possibly significant factors found current cigarette use (odds ratio [OR] = 9.73), insulin dependent diabetes onset after 8.4 years of age (OR = 3.36), and age greater than 32 years (OR = 3.00) explained the majority of the extensive periodontal disease in this group of diabetic patients.

Conclusions: Management and prevention of extensive periodontal disease for Type 1 diabetic patients should include strong recommendations to discontinue cigarette smoking. *J Periodontol 1999;70:409-417.*

KEY WORDS

Diabetes mellitus, insulin-dependent; oral health; smoking/adverse effects; periodontal diseases/etiology; follow-up studies.

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Oral health complications reportedly associated with diabetes that may be encountered by dental practitioners include xerostomia, tooth loss, gingivitis, periodontitis, odontogenic abscesses, caries, and soft tissue lesions of the tongue and mucosa.[1-3] Diabetes mellitus is a chronic metabolic disorder that affects over 12 million people in the United States and probably 100 million people worldwide.[4] Diabetes is the sixth leading underlying cause of death in the United States and has been estimated to cost 20.4 billion dollars annually in medical costs and lost productivity.[5] Medical complications associated with diabetes include renal disease, retinopathy, neuropathy, peripheral vascular disease, and coronary heart disease.[6] The impact of diabetes on medical and oral health, as well as the goals of disease prevention, was addressed in the US Public Health Service publication Healthy People 2000.[7] Research and preventive care to decrease mortality associated with diabetes, decrease medical complications, and prevent the oral health sequelae in this special population were emphasized.

The reported prevalences and characteristics of periodontal disease complications associated with diabetes may be dependent on the type of diabetes studied. Diabetes is commonly categorized as insulin dependent diabetes mellitus (IDDM) and non-insulin depen-

dent diabetes mellitus (NIDDM). Approximately 10 to 20% of all diabetic patients are insulin dependent or Type 1. These patients usually have rapid onset of symptoms and are characterized by a virtually complete inability to produce insulin. Nearly 90% of Type 1 patients are diagnosed before the age of 21. NIDDM or Type 2 diabetes, the most common type diabetes, is characterized by slow onset of symptoms, usually after 40 years of the age. Other less prevalent forms of diabetes include gestational diabetes seen during pregnancy and diabetes secondary to other medical conditions.[8]

When compared to healthy subjects, gingival and periodontal diseases are often reported to be more prevalent in insulin and non-insulin dependent diabetic individuals.[3,9,10] The consequences of periodontal disease and subsequent tooth loss are not only important considerations for the quality of life of a diabetic patient, but may significantly impact on overall health by compromising a patient's ability to maintain a healthy diet and proper glycemic control.[11] Although not universally accepted, the association of Type 1 and Type 2 diabetes with an increase in the risk of tooth loss has also been reported.[12-14] The poor periodontal health of Type 2 diabetic patients has been extensively evaluated in the Pima Indian population in Arizona.[14] Diabetic status is significantly associated with attachment and bone loss in this population. Periodontal disease in the younger Type 1 diabetic patient has not been as consistently reported.[15,16] Reported oral health differences between Type 1 and Type 2 patients may relate to differences in glycemic control strategies, age, duration of disease, access and utilization of dental care, or periodontal disease susceptibility.

The objective of the current study was to describe the periodontal status of a large adult population of Type 1 diabetic patients and to evaluate the multiple demographic, behavioral, and medical factors that may be associated with extensive periodontal disease.

MATERIALS AND METHODS

Research Design

The diabetic subjects recruited into this oral health study were ongoing participants of the University of Pittsburgh Epidemiology of Diabetes Complication Study (EDC). This cohort was derived from the Children's Hospital of Pittsburgh registry of early-onset (<17 years of age) insulin dependent diabetes mellitus (Type 1) and has been previously shown to be representative of the Type 1 residents within Allegheny County.[17] Eligible cases for the EDC cohort were patients diagnosed between January 1, 1950 and May 31, 1980 who lived within 100 miles of Pittsburgh. Of 979 eligible subjects, 788 (80%) provided questionnaire data and 658 (67%) received medical examinations at baseline (1986-1988). At 2-year intervals since baseline, the EDC continues to provide medical examinations to determine the incidence of retinopathy, nephropathy, neuropathy, and cardiovascular disease within this cohort.

For the oral health evaluation, subjects scheduled for one of their regular 2-year examinations for the EDC cohort study were contacted by members of the University of Pittsburgh Oral Health Science Institute, informed of the purpose of the oral health evaluation, and asked to participate. Between March 1992 and August 1994, 406 patients were recruited and examined. Questionnaires requesting medical and dental histories, oral health behaviors, and psychosocial information were mailed prior to their appointment. Appointments for the exams were scheduled between 7:00 and 11:00 a.m. on Wednesday and Saturday mornings. Subjects were asked not to eat or drink after midnight prior to their appointment. Upon arrival, their questionnaires were reviewed and an IRB approved consent form was presented and signed.

The oral health exam was performed in a separate room equipped with a portable dental chair and a side mount dental examination light. Initially, the EDC staff collected urine and blood samples and recorded blood pressure. The usual sequence of the oral health exam involved cytological sampling of the tongue for *Candida*, collection of whole saliva, and an assessment of minor salivary flow. Subjects then received their normal insulin injection and breakfast. During breakfast, the oral health research associate interviewed all subjects regarding dietary habits and provided instructions for the proper completion of a one-day diet diary. Following breakfast, an oral soft tissue pathology exam, a full mouth coronal and root caries exam, and a split mouth periodontal exam were performed. Subjects at risk for bacterial endocarditis or other bacteremia induced infections were excused from the periodontal probing assessments. Specific methods and results of the tooth loss, caries, saliva, and soft tissue disease assessments will be published separately.[18] The oral health assessments required approximately 25 minutes.

Following the oral health examination, the subjects underwent EDC assessments for possible medical complications of diabetes. These assessments included a physical exam; an EKG; an additional urine sample; and an evaluation of renal, neural, retinal, and cardiovascular functions (see below).

Oral Health Assessment Methodology

During the initial interview, demographic data, and medical and dental histories were reviewed. Demographic data included age, gender, weight, height, race, highest level of education, marital status, and income (within $10,000 increments). The medical history solicited information regarding current medical

care, medications, hospitalizations, significant medical histories (hepatitis, epilepsy, etc.), allergies, cardiac murmurs and/or valve surgery, prosthetic hip replacements, and pregnancy. The dental history solicited information regarding dental care, most recent visits to the dentist, oral hygiene habits (use of fluoride toothpaste, frequency of brushing and flossing), community water fluoridation, perceived treatment needs, and dental insurance. Published and validated questions regarding dental anxiety (dental anxiety scale) and xerostomia (subjective xerostomia questionnaire) were also included.[19,20]

Subjects were questioned regarding their use of tobacco products, including use of smokeless tobacco as well as current and lifetime history of cigarette use (start age, duration, consumption). Total weekly alcohol consumption was determined from a questionnaire that elicited weekly consumption estimates for tea and coffee; regular, diet, and caffeine-free soft drinks; and beer, wine, and mixed drinks/liquor. Data for weekly wine, beer, and liquor consumption were summed to provide an estimate of weekly alcohol consumption (ounces per week).

Missing teeth. All missing teeth excluding third molars were recorded. A modification of the NIDR adult survey criteria included eliciting the likely cause of loss to distinguish between extraction due to disease or due to orthodontic treatment.[21]

Periodontal disease. Because of time limitations, periodontal assessments were made on 2 randomly designated quadrants: maxillary left/mandibular right or maxillary right/mandibular left. Using methods described by the NIDR adult survey, 3 sites on the buccal/facial surface of each tooth (mesial, mid-cervical and distal) were probed.[21] Measurements from the gingival crest to the cemento-enamel junction (CEJ) and to the base of the pocket were made by one of two trained dentists. Attachment levels and probing depths (PD) were measured using a standard CPITN pressure controlled probe graduated at 2, 4, 6, 8, 10, and 12 mm. Third molars were excluded. Calibration sessions for the two dentist examiners used throughout the study were carried out prior to the initiation of the study and periodically during the 2 years of data collection. Inter-examiner agreement (I.C.C.'s) prior to the study ranged from 0.813 to 0.832 for mesial, 0.688 to 0.785 for cervical and 0.645 to 0.832 for distal probing measures. Mean estimates (± s.e.) for the two examiners were 0.93 ± 0.08 mm and 0.94 ± 0.07 mm.

For bleeding on probing measures the NIDR adult survey criteria and methods were used.[21] The periodontal probe was gently inserted no more than 2 mm into the gingival sulcus. Bleeding on probing (BOP) was assessed as present or absent for each tooth examined. Visual assessments of supragingival calculus on each tooth was rated as present or absent.

Assessment of Diabetic Complication

Diabetes complication measures and risk factors studied by the EDC included glycemic control, nephropathy, neuropathy, retinopathy, and peripheral vascular disease.[6,22-25] Published criteria for medical complications that were used for this oral health analysis have been recently summarized[18] and categories used for the statistical analyses are described below.

Data Management and Analyses

All data were initially screened for accuracy and completeness. EDC and oral health files were merged and converted for creation of summary variables. Final analysis was carried out using a Macintosh Power PC and JMP software.[ll]

Differences in the prevalence rates of periodontal disease indices for each of the 6 age categories were summarized and compared using ANOVA for continuous variables and chi square analyses for categorical variables. To address dependent demographic, behavioral, and medical factors possibly associated with periodontal disease in these diabetic subjects, a classification of "extensive periodontal disease" was created. Subjects with loss of attachment levels of ≥4 mm in more than 10% of periodontal sites examined were so defined. This parameter was selected to describe a clinically significant amount of disease, include ample subjects for further regression analyses, and minimize misclassification of cases due to possible measurement error. The resultant binary variable (presence/absence) of extensive periodontal disease was used as the dependent variable in a nominal logistic regression model. Crude odds ratios of extensive periodontal disease were calculated for all possible demographic, behavioral and medical variables. All potentially significant covariates ($P \leq 0.20$) were entered and sequentially omitted in developing the final model based on a $P \leq 0.05$ criteria. All variables that were initially entered were then re-entered individually to assure that they were appropriately excluded with the descending stepwise procedure. Finally, possible interactions between variables found to be significant in the final model were evaluated. Goodness-of-fit was evaluated using the log-likelihood and chi square statistic.

Potential explanatory variables so examined (created by dichotomizing the continuous and categorical variables based on median or clinically relevant values of the entire population) were: age (greater than the median age of 32 years), gender, household income (less than $20,000), education (high school or less), now smoking cigarettes, having ever smoked cigarettes, having ever chewed tobacco, alcohol consumption (greater than 7 ounces per week), tooth brushing (one or fewer times per day), use of dental floss ever, use of fluoride toothpaste, currently living in a commu-

Table 1.

Population Demographics

	Males	Females	Total
Age Category			
<24 years	28	31	59
25-29	40	28	68
30-34	45	33	78
35-39	37	29	66
40-44	20	12	32
>45 years	8	9	17
Total	178	142	320
Age			
Mean year (+s.e.)	32.2±.58	32.0±.65	32.1±.43
Age at Onset			
Mean year (+s.e.)	8.2±.31	8.6±.35	8.4±.23
Duration of Disease			
Mean year (+s.e.)	24.0±.56	23.4±.62	23.7±.41
Height			
Mean cm (+s.e.)	173.0±.53	162.8±.59	167.0±.50
Weight			
Mean kg (+s.e.)	75.0±.77	64.5±.86	70.3±.64

nity with fluoridated water, having visited a dentist in the last 12 months, presence of xerostomia symptoms (positive response to one or more questions on Fox's xerostomia questionnaire[19]), dental anxiety (dental anxiety scale greater than 8[20]), age of diabetes onset greater than the median age of 8.4 years, duration of disease (longer than median age of 24 years), glycosylated hemoglobin (≥10.1%A1 characterized as poor; note that total glycosylated homoglobin was measured as %A1, and not specific to only %A1c), nephropathy (ratings of overt and renal failure), neuropathy (rating of definite), retinopathy (ratings of advanced or proliferative), and peripheral vascular disease (present).

RESULTS

The oral health team contacted by mail 412 subjects who were scheduled for their EDC appointments and enrolled 406 IDDM subjects willing to participate. Sixteen subjects were missing all of their teeth, 2 had scheduling conflicts that prevented complete oral health assessments, and 68 were excluded from the periodontal exam for possible risk of bacteremias.[26] The remaining 320 subjects had a mean age of 32.1 years, a mean age at onset of insulin dependent diabetes mellitus of 8.4 years, a mean height of 167.0 cm, and a mean weight of 70.3 kg (Table 1). This predominantly white and non-Hispanic (98%) diabetic study population consisted 178 males and 142 females.

The mean duration of disease for these diabetic subjects was 23.7 years (± 0.4 s.e.) while the mean glycosylated hemoglobin level was 11.0% (± 0.1 s.e.). Assessments of diabetic complications by the EDC at the time of the oral health examination found 39% to have advanced or proliferative retinopathy, 18% to have overt nephropathy or renal failure, 22% to have definite peripheral neuropathy, and 9% to have definite peripheral vascular disease.

Variation in periodontal disease indices with age are shown in Table 2. Measures of loss of attachment generally increase with age. Severe loss of attachment (>6 mm) was uncommon even in the upper age category. Bleeding on probing (BOP) was consistent among subjects at each age group and show no apparent trend. Supragingival calculus was more prevalent in the older subjects, although this tendency was not statistically significant.

All factors possibly associated with extensive periodontal disease and used for the regression analysis are provided in Table 3. These factors included in the regression analysis were age ($P < 0.001$), household income ($P = 0.026$), education ($P = 0.019$), current smoking cigarettes ($P < 0.001$), having ever smoked cigarettes ($P < 0.001$), tooth brushing less than once per day ($P = 0.017$), infrequent visits to the dentist ($P = 0.068$), late age of diabetes onset ($P < 0.001$), longer duration of disease ($P = 0.034$), elevated glycosylated hemoglobin %A1 ($P = 0.119$), neuropathy ($P = 0.017$), and peripheral vascular disease ($P = 0.060$).

The final regression model for extensive periodontal disease is presented in Table 4. No interactions terms entered the final model. A goodness-of-fit test ($P = 0.169$) suggests that the regression model was appropriate for these data. While adjusting for all other measures associated with disease, the diabetic subjects with extensive periodontal disease were best characterized as having late onset of IDDM, older age, and to be currently smoking cigarettes. These relationships are characterized in Figure 1.

DISCUSSION

The overall prevalence of periodontal disease in this Type 1 diabetic population was slightly lower than rates reported by the 1985-1986 NIDR adult survey of oral health in employed adults.[21] However, the specific rates for LOA, BOP, and calculus should be compared to published surveys with caution. The actual values vary depending on the year when the study was performed, assessment criteria, examiner interpretations, and specific population characteristics. Because the periodontal variables are dependent on teeth being present, variations in the rate of tooth loss in a specific population may significantly influence the findings. We have previously reported that the prevalence of edentulism was higher in this diabetic population when compared to

Table 2.

Periodontal Disease Indices Versus Age

	Age Category (years)						
	<24	25-29	30-34	35-39	40-44	>45	Overall
Loss of attachment (LOA)* Mean mm ± s.e.	0.95±0.9	1.19±.09	1.31±.08	1.36±.08	1.39±.12	1.23±.16	1.23±.04
Subjects with any LOA ≥4 mm† % in age category	11.9	32.4	41.0	34.9	31.3	58.8	32.5
Sites with LOA ≥4 mm‡ % of sites/subject	0.4	3.3	4.1	5.6	5.2	6.1	3.8
Subjects with 10% of sites LOA ≥4 mm† % in age category	0.0	5.9	11.5	15.2	21.9	23.5	10.6
Subjects with any LOA ≥6 mm* % in age category	0.0	10.3	6.4	10.6	12.5	23.5	8.4
Sites with LOA ≥6 mm % of sites/subject	0.0	0.4	0.5	1.3	1.6	1.7	0.7
Subjects with 10% of sites LOA ≥6 mm % in age category	0.0	1.5	1.3	3.0	3.1	5.9	1.9
Deepest LOA for each subject* mean mm ± s.e.	2.61±1.9	3.32±.18	3.31±.17	3.38±.18	3.44±.26	3.94±.36	3.24±.08
Subjects with any BOP % in age category	86.4	67.7	71.8	66.7	65.6	76.5	72.2
Teeth with BOP % in age category	21.9	23.4	20.8	18.3	15.3	20.4	20.5
Subjects with any calculus % in age category	11.9	14.7	12.8	13.6	15.6	17.6	13.8
Teeth with calculus % of teeth/subject	2.1	3.3	4.0	2.9	4.4	7.4	3.5
* P <0.05. † <0.01. ‡ <0.001.							

national reports.[18] This selective loss to the analysis (16 subjects) may have created a slight underestimation of periodontal disease when compared to other surveys, particularly in the older age categories where most of the edentulism occurred. Similarly, the exclusion within this study of diabetic subjects with a risk of endocarditis or related bacteremia induced infections may have eliminated patients with greater periodontal problems and resulted in an underestimation of disease. While allowing for these variations, there is little to suggest that the periodontal status of this adult population of Type 1 diabetic subjects (mean age 32.2 years) is significantly different than the NIDR survey findings.

The Type 1 diabetic population evaluated in this study, unlike the NIDR employed adult study population, had an employment rate of 69.5%. The impact of employment and subsequent higher household income

on oral health care may be significant. Given that chronic medical diseases such as diabetes may be associated with poor general health, physical disabilities, and subsequent limited employment opportunities, caution should be taken when assessing the impact of the pathophysiology of a chronic disease such as diabetes on oral health when socioeconomic status is unknown.

When compared to available data from the NIDR adult survey,[21] the periodontal variables presented in Table 2 show similar trends with age. Across the ages studied, the mean loss of attachment increases 25 to 30% in both studies (0.95 to 1.23 in Table 2) and (2.08 to 2.71 in the NIDR study[21]). Because the association of periodontal disease with increasing age is not a linear relationship, the increase in the prevalence of LOA with age reported here would probably be greater if older

subjects had been studied. Trends in BOP with age are essentially nonexistent in both studies (21.9% to 20.4% in Table 2; 5.39% to 5.36% in the NIDR study[21]). Similarly, the prevalence of supragingival calculus seems to increase with age (11.9% to 17.6% in Table 2; 23.70% to 39.71% in the NIDR study[21]). Similar trends with age are seen in the prevalence rates reported for periodontal variables in the recent NHANES III report.[27]

The results of the current study confirm the important role of cigarette smoking in the prevalence and severity of periodontal disease reported by Haber and Kent.[28,29] The odds ratio of 9.73 for the association with smoking found in the current study closely agrees with their findings of 6.9 (95% C.I. of 2.6 to 18.5) for Type 1 diabetic subjects 19 to 40 years of age. Many mechanisms have been put forth for the deleterious effects of smoking including vascular, immunologic, and toxicological.[30] Although the specific causes are not known, smoking habits appear to be one of the most important factors associated with periodontal disease. This finding has obvious implications for treatment and prevention of periodontal diseases in a clinical setting.

The prominent role of smoking as a risk factor for periodontal disease has significant implications for designing controlled clinical trials and oral health epidemiologic studies. The primary method used for determining smoking behavior is self reporting. With the ever increasing negative attitudes regarding tobacco use both in the public and the medical community, it is likely that a subject's reported smoking habits (current and past) are, at best, underestimated and probably even denied

Table 3.

Factors Associated With Extensive Periodontal Disease (EPD)

Factor	Number	EPD Prevalence	Odds Ratio	95% C.I.	P Value
Demographics					
Age					
> 32 years	155	16.8%			
			3.96	1.81-9.62	<0.001
≤ 32 years	165	4.9%			
Gender					
Males	178	12.4%			
			1.53	0.74-3.30	0.262
Females	142	8.5%			
Household income*					
≤ $20,000	62	17.7%			
			2.49	1.08-5.48	0.026
> $20,000	238	7.9%			
Education					
≤ High School	94	17.0%			
			2.37	1.14-4.89	0.019
Beyond high school	226	8.0%			
Tobacco and Alcohol Consumption					
Current cigarette smoking					
Yes	61	34.4%			
			9.93	4.67-21.9	<0.001
No	259	5.0%			
Chewing tobacco now					
Yes	44	9.1%			
			0.82	0.23-2.22	0.723
No	278	10.9%			
Cigarette smoking history					
Previously smoked	113	22.1%			
			6.25	2.90-14.67	<0.001
Never smoked	207	4.4%			
Alcohol consumption*					
> 7 ounces/week	96	13.5%			
			1.56	0.73-3.25	0.242
≤ 7 ounces/week	219	9.1%			
Dental Health Behaviors					
Tooth brushing					
< once / day	85	17.7%			
			2.44	1.16-5.04	0.017
≥ once / day	235	8.1%			
Use of dental floss					
No	96	13.5%			
			1.51	0.71-3.13	0.270
Yes	224	9.4%			
Use of fluoride toothpaste*					
No	7	14.3%			
			1.36	0.07-8.41	0.778
Yes	248	10.9%			
Currently living in area with fluoridated water*					
No	91	8.8%			
			0.712	0.27-1.77	0.473
Yes	109	11.9%			
Visited a dentist in last year					
No	97	15.5%			
			1.96	0.94-4.04	0.068
Yes	223	8.5%			
Xerostomia symptoms*					
1 or more	79	12.7%			
			1.31	0.57-2.80	0.500
none	241	10.0%			
Dental anxiety*					
CAS > 8	120	11.7%			
			1.18	0.56-2.41	0.662
CAS ≤ 7	198	10.1%			

Table 3. (continued)

Factors Associated With Extensive Periodontal Disease (EPD)

Factor	Number	EPD Prevalence	Odds Ratio	95% C.I.	P Value
IDDM					
Age of Onset					
> 8.4 years	161	16.8%	4.38	1.94-11.20	<0.001
≤ 8.4 years	159	4.4%			
Duration of IDDM					
> 24 years	142	14.8%	2.20	1.07-4.68	0.034
≤ 24 years	178	7.3%			
Glycosylated hemoglobin					
poor (>10.1% A1)	226	12.4%	2.07	0.88-5.70	0.119
fair	94	6.4%			
Nephropathy					
overt or renal failure	58	13.8%	1.45	0.59-3.27	0.389
none/microalbuminuria	262	9.9%			
Neuropathy					
definite	70	18.6%	2.49	1.15-5.22	0.017
none or probable	250	8.4%			
Retinopathy					
advanced or proliferative	126	11.9%	1.24	0.60-2.54	0.550
none or early	194	9.8%			
Peripheral vascular disease					
present	28	21.4%	2.57	0.89-6.55	0.060
absent	292	9.6%			
*Incomplete reporting					

Table 4.

Regression Model for Periodontal Disease in IDDM Subjects

Factor	Odds Ratio	95% C.I.
Currently smoking cigarettes	9.73	4.40-22.4
Age at onset greater than 8.5 years	3.36	1.38-9.15
Age greater than 32 years	3.00	1.26-7.83

by some research participants. For many of the study designs and outcome measures used in assessing periodontal treatment outcomes, the results could be masked by inaccurate assessment of smoking behaviors. Blood assays for cotinine or other laboratory confirmations of smoking behavior may be necessary for certain kinds of clinical periodontal research.

It is remarkable that most of the factors related to extensive periodontal disease listed in Table 3 were not found significant in the final regression model. Age and smoking may explain or correlate with many of the demographic, general health habits, dental behaviors and IDDM variables. For example, age is significantly associated with the severity of periodontal disease as well as duration of IDDM and the diabetic complications neuropathy and peripheral vascular disease.

Poor glycemic control as assessed by glycosylated hemoglobin (%A1) was not associated with periodontal disease in the final regression model. Glycemic control and medical complications of diabetes such as retinopathy have been previously reported to be related to periodontal disease.[31-33] Elevated blood glucose and glycosylated hemoglobin values, with subsequent medical complications, may be common etiologic factors for the pathophysiology of dental diseases or may possibly be viewed as surrogates for poor health behaviors. The lack of a strong association between periodontal disease and glycosylated hemoglobin may indicate the primary importance of smoking as a factor in determining periodontal disease status. Previous reports of associations between periodontal disease and specific medical complications such as retinopathy or neuropathy may not have been able to adequately adjust for these confounding factors.

Significant risk factors associated with periodontal disease in diabetic populations include both age and duration of disease. Unlike Type 2 diabetes, Type 1 is well defined, has a rapid onset of symptoms, and rarely continues undiagnosed. The current population, restricted to early-onset diabetes, had a mean onset age of 8.4 (± 0.2 s.e.) years and a duration of disease of 23.7 (± 0.4 s.e.) years. Because the duration of disease in early-onset Type 1 diabetes population is highly correlated with age (r = 0.868), the oral health consequences of this variable is explained primarily by age in the final model.

The significant association between late onset of diabetes and severe periodontal disease (Fig. 1, bottom) was not expected. In fact, since age at onset plus years of disease duration is equal to a subject's age, one would expect that for a subject with a given age, a longer duration of disease would require an early-onset of disease. As can be seen in Figure 1B, the late-onset subjects (mean age of 11.9 years) had more extensive periodontal disease at each of the age categories than the early-onset subjects (mean age of 4.8 years).

Current Smoking Habits
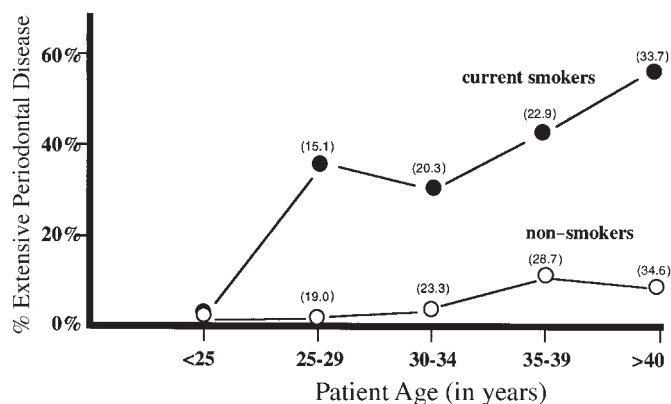
Age of Onset of Type 1 Diabetes
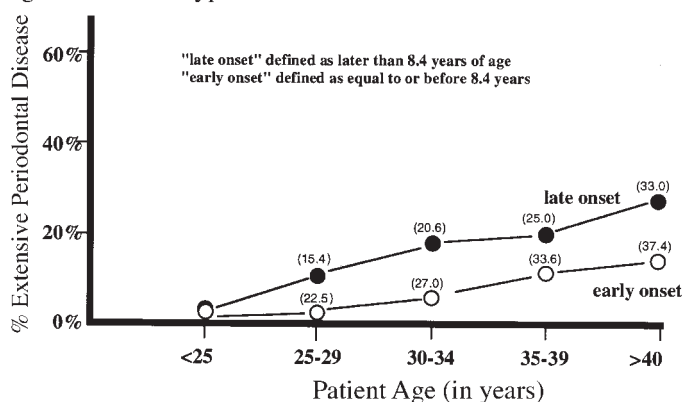
Figure 1.

The percentage of subjects that were found to have extensive periodontal disease at each age category displayed. Extensive periodontal disease was defined as a patient with LOA ≥ 4 mm in more than 10% of the periodontal sites examined. The upper panel reports differences in periodontal disease between current cigarette smokers and non-smokers while the lower panel reports differences between subjects having later-onset (mean age 11.9 years) and earlier-onset (mean age 4.8 years) of Type 1 diabetes. The numbers in parentheses are the mean durational years of diabetes at each age category.

This unexpected finding has not been reported for periodontal disease prevalence in Type 1 diabetes previously. However, there is evidence that for the risk of medical complications of diabetes, the durational years of diabetes prior to puberty contribute only minimally.[22,34] While the mechanism for this relationship is not known, alterations in growth and sex hormonal levels, and subsequent physiologic changes during adolescence may be most sensitive to uncontrolled glucose metabolism.[35] Additionally, although a physiologic mechanism may be a contributing factor, behavioral difference between prepuberty and adolescence might have a greater impact. For example, within our diabetic population, smoking was reported more frequently for late-onset subjects than early-onset subjects (59% versus 41%). The duration of smoking behaviors, and psy-

chosocial factors associated with inadequate compliance with glycemic control measures, could be responsible for the higher prevalence of periodontal disease in late-onset Type 1 diabetes.

CONCLUSIONS

The medical and oral health status of 320 patients previously diagnosed with Type 1 diabetes mellitus was thoroughly evaluated. For this adult diabetic population with a mean age of 32.1 years, periodontal disease was uncommon. Cigarette smoking, older age, and a later age of diabetes onset were associated with a higher prevalence of extensive periodontal disease. Management and prevention of extensive periodontal disease for this patient population should include strong recommendations to discontinue cigarette smoking.

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