Periodontal treatment needs in a follow-up study among adults with diabetes in Finland

Aija Karikoski and Heikki Murtomaa
Department of Oral Public Health, Institute of Dentistry, University of Helsinki, Finland

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We assessed changes in periodontal treatment needs among patients with diabetes and the risk factors involved in this phenomenon. The sample consisted of 120 dentate subjects, all of whom were regular patients at the Salo Regional Hospital Diabetes Clinic. They underwent periodontal examination in 1999 and were re-examined in 2001. The drop-out rate was 4%. Clinical periodontal examination included identification of visible plaque, the presence of calculus, and use of the Community Periodontal Index of Treatment Needs (CPITN) index. Diabetes-related factors consisted of information about duration of diabetes, complications, and $HbA1_c$ values. Oral health-related factors were collected by questionnaire. The CPITN index proved to be insensitive to change. Pathological pockets (CPITN 3 or 4) were found in 80% of subjects ($n = 115$) and 48% of sextants ($n = 627$); in 1999, the corresponding rates were 77% and 49%. The tooth-based individual CPITN index (code 3 or 4) revealed periodontal deterioration in 38 patients. Smoking and infrequent interdental cleaning were significant factors explaining periodontal deterioration in logistic regression. Risk factors should be taken into account when planning prevention, treatment, and supportive periodontal therapy strategies. In diabetes care, the common risk factor approach can be implemented to promote oral health among individuals with diabetes. □ *Diabetes; periodontal treatment needs; risk factors*

Aija Karikoski, Department of Oral Public Health, Institute of Dentistry, P.O. Box 41, FI-00014 University of Helsinki, Finland. Tel. +358 40 535 3982, fax. +358 9 191 273 46, e-mail. aijakarikoski@hotmail.com

Oral health problems have risk factors in common with a number of important chronic diseases. Sheiham & Watt (1) concluded that further improvements in oral health would only be secured through the adoption of oral health promotion policies based upon the common risk factor approach. Moreover, they stated that the main risk factors for chronic diseases frequently cluster in the same individuals (1). Diabetes is a common chronic disease that has a two-way relationship with periodontal disease (2).

The goal of periodontal diagnosis, treatment planning, and therapy is to lower the risk for future periodontal deterioration (3). Identified risks include smoking, certain systemic diseases, aging, oral hygiene status, and micro-organisms, history of periodontitis, family history, and genetic factors (3–6). In addition, frequency of dental visits (3), socioeconomic factors, and gender have been suggested to pose risks (4, 6). Kornman (7) concluded that while bacteria are essential for the initiation and progression of periodontitis, factors such as smoking, diabetes, and genetics appear to strongly influence the severity of the disease and the response to treatment. Genetic factors play a major role in determining disease susceptibility, especially the early onset of periodontitis (3, 8). There is currently little or no intervention possible to lower the level of risk from genetic factors (3).

The present longitudinal study is part of a community trial reflecting real life, with results of the oral self-care promotion intervention reported separately. Subjects with diabetes were investigated in 1999 (9, 10) and re-examined 2 years later. The aim of the study was to assess possible changes in periodontal treatment needs and to examine periodontal risk factors in this process.

Subjects and methods

Patients

The subjects consisted of 120 dentate patients with diabetes (type 1; $n = 91$, type 2; $n = 26$, other type $n = 3$), all of whom were regular visitors at the Salo Regional Hospital Diabetes Clinic in South-west Finland. The criteria for inclusion and the demographic and clinical characteristics of the patients have been described in our previous papers (9, 10). The subjects underwent periodontal examination in 1999 and were invited to participate in a follow-up examination in 2001. Two participants had died, one had moved, one had received full dentures, and one had refused to participate. Thus, the number of patients participating in the follow-up was 115 (96%). The clinical examination was performed by the same examiner (AK) as in 1999, and the methods applied in 1999 and 2001 were identical.

Methods

Questionnaire

The self-completed questionnaire contained 22 items, following the same pattern used in our previous studies (10, 11). Age was dichotomized as <40 years versus ≥40 years. The degree of education was categorized either as low, comprising primary, secondary, comprehensive or high school, and different forms of technical education, or as high, comprising a college or university degree. Smoking habit was dichotomized as smoking (originally

Table 1. Subjects classified by their highest *CPITN score in 1999 and 2001. Percentage in parentheses

		Subjects with highest CPITN score in 2001			
	CPITN	0–2	3	4	Total
Subjects with highest CPITN score in 1999	0–2	21	5	0	26 (22.6)
	3	2	59	3	64 (55.7)
	4	0	8	17	25 (21.7)
	Total	23 (20.0)	72 (62.6)	20 (17.4)	115 (95.8)
	Drop-outs	0	2 (1.7)	3 (2.5)	5 (4.2)

* Community Periodontal Index of Treatment Needs.

the alternatives were regular and occasional smoking) and no smoking (originally the alternatives were stopped smoking and no smoking habit). Oral health habits were dichotomized as follows: brushing at least two times a day versus more seldom, cleaning interdental space daily versus more seldom, and dental visits at least once a year versus more seldom.

Diabetes status

Information about complications and duration of disease was collected from our 1999 study, but $HbA1_c$ values (glycosylated hemoglobin) were also collected from patients' records between 1999 and 2001. For data analysis, diabetes variables were dichotomized as follows: no complications versus one or more complications, duration of disease $\leq$10 years versus >10 years, and $HbA1_c$ value $\leq$8.5% versus $\geq$8.6%.

Clinical periodontal examination

One examiner (AK) performed all clinical measurements in a regular dental clinic. The examination comprised calibrated recordings for all remaining teeth, excluding third molars. The following variables were included:

1. Visible plaque. The presence of visible plaque on four surfaces of each tooth was assessed after drying with air. This corresponds to criteria for scores 2 and 3 of the Plaque Index System (12). The percentage of surfaces with visible plaque was calculated.
2. Calculus. The presence of supra- and subgingival calculus was measured using a World Health Organization (WHO) probe from the six sites of each tooth. The percentage of surface with calculus was calculated. For data analysis, the calculus index was dichotomized into $\leq$60% versus >60%.
3. Community Periodontal Index of Treatment Needs (CPITN). Periodontal treatment needs were assessed by means of the CPITN system (13). The recordings were based on the code number observed after examination of all remaining teeth, excluding third molars, in each of the six segments (sextants) containing at least two functional teeth from six sites of the tooth. The subjects, sextants and teeth were classified according to the highest code number recorded (codes 0–4). For each subject, an individual tooth-based CPITN index was calculated. The examination was performed using a 2.5 magnification surgical telescope.

CPITN recordings were made using the following code numbers: Code 0 = healthy periodontal tissue; Code 1 = bleeding after probing; Code 2 = supra- or subgingival calculus and/or overhang(s) of filling(s) or crown(s); Code 3 = pathologic pocket(s) 4 or 5 mm; Code 4 = pathologic pocket(s) $\geq$6 mm.

Intra-observer reliability was studied in 21 participants with CPITN score 3 or 4 by re-examination after a 1- to 2-week interval. Of the total number of patients (n = 21) with CPITN scores 3 and 4, one (4.8%) patient's score differed from the original one. For the original sextant measurements (n = 119) and for the original teeth measurements (n = 527), the rates were 6.7% and 7.2%, respectively.

The individual tooth-based CPITN index was chosen as the dependent variable and dichotomized as improved or stable/deteriorated and stable/improved or deteriorated. Changes between CPITN scores 0, 1, and 2 were not recorded. The need for treatment was considered as decreased/increased for teeth if the number of teeth with decreased/increased scores was higher than the number of teeth with increased/stable scores and, in the case of deterioration, the number of teeth with decreased/stable scores.

Because the risk for future periodontal deterioration in a given individual is strongly associated with the presence and severity of existing periodontitis (2), history of periodontitis was studied with a variable that was collected in the 1999 examination and dichotomized as follows: at least three sextants with code 3 or one sextant with code 4 versus less than 3 sextants with code 3 or no sextants with code 4.

Statistical analysis

The Wilcoxon rank test was used to analyze the changes in plaque, calculus, and CPITN indices in 1999 and 2001. Changes in periodontal treatment needs and potential factors affecting this phenomenon were analyzed in baseline with the Pearson chi-squared test. Effects of the potential factors on the probability of having a deteriorated tooth-based CPITN score were investigated using a

Table 2. Mean number of sextants affected (0 = healthy, 1 = bleeding, 2 = calculus, 3 = shallow pockets, 4 = deep pockets) per subject. *n* = number of sextants. Number of missing sextants was 63

	1999		2001	
*CPITN codes	*n*	Mean	*n*	Mean
0	14	0.12	16	0.13
1	123	1.07	108	0.94
2	183	1.59	203	1.77
3	257	2.23	256	2.23
4	50	0.43	44	0.38
Total	627	5.44	627	5.45

* Community Periodontal Index of Treatment Needs.

logistic regression model. The level of significance was set at $P < 0.05$. Statistical analyses were performed using SPSS for Windows 7.5.

Results

Periodontal health

Distributions of CPITN scores in 1999 and 2001 are given in Table 1. No CPITN score of 0 was found for either year. In addition, no significant change in CPITN scores ($P = 1.000$) was present between 1999 and 2001. Pathologic pockets (CPITN 3 or 4) were found in 77.4% of subjects and 49.1% of sextants ($n = 627$) in 1999, and in 2001 the rates were 80.0% and 47.8%, respectively. Table 2 gives the percentage of subjects with CPITN codes 0–2, 3, and 4 per sextant in 1999 and 2001, after drop-outs were excluded from 1999 statistics. For 44 subjects, the individual tooth-based CPITN score had improved, and for 38 subjects deteriorated, when changes between CPITN scores 0, 1, and 2 were not included.

In 1999 ($n = 115$), the mean number of surfaces with calculus was 32.5% (s (SD) $\pm$ 23.1%) and with visible plaque 27.4% ($s \pm 21.8\%$), and in 2001 the corresponding proportions were 26.4% ($s \pm 19.8\%$) and 16.7% ($s \pm 16.8\%$). The change in calculus and plaque rates was significant ($P < 0.001$) for the whole study group.

Modifiable risk factors

Oral self-care. During the previous year, 73% (71% from the 1999 questionnaire) of subjects had had a dental appointment, and a further 20% (18%) had had a dental appointment between 1 and 2 years previously. An interval of more than 5 years was found for 3% (4%) of those surveyed. The main reason for the last dental visit was a normal check-up for 62% (60%), and the rate of those reporting pain or some other reason requiring urgent treatment was the same for both years, 23%. The proportion of those who had received a physician's referral for dental care had also remained constant, at 3%.

Of the total number of subjects ($n = 115$), 31% in 1999 reported brushing their teeth more often than once a day; in 2001, the rate was 34%. In 1999, slightly less than 21% reported cleaning the interdental space at least once a day, while in 2001 the proportion was almost one-third (29%). The proportion of those reporting never cleaning the interdental space had decreased from 27% in 1999 to 16% in 2001. The toothpick was still the most common device (66%) for interdental cleaning.

Smoking habit. The number of smokers in the whole study group ($n = 115$) was 26 (23%) in 1999 and 23 (20%) in 2001.

Diabetes status. The mean $HbA1_c$ value was 8.2% ($s \pm 1.2\%$) for the 1999–2001 study period; the mean number of assays was 5.8 ($s \pm 1.3$). In 1999 the mean $HbA1_c$ value was 8.3% ($s \pm 1.2\%$) and 8.2% ($s \pm 1.2\%$) in 2001.

Table 3. Factors associated with tooth-based deteriorated *CPITN score ($n = 38$) when changes between scores 0, 1, and 2 are not taken into consideration

		Tooth-based deteriorated CPITN		
Factor	*n*	OR	95% CI	*P*
Age		0.73	0.32–1.66	0.322
<40 years	37			
≥40 years	78			
Gender		2.23	0.99–5.22	0.053
Female	48			
Male	67			
Education		1.30	0.57–2.99	0.537
Low	80			
High	35			
Smoking		0.29	0.11–0.74	0.010
Smoking	23			
No smoking	92			
Dental visits		0.40	0.17–0.94	0.036
≥1 year ago	31			
<1 year ago	84			
Tooth brushing		0.86	0.37–1.96	0.710
<2 × day	76			
≥2 × day	39			
Interdental cleaning		0.35	0.13–0.93	0.036
<1 × day	82			
≥1 × day	33			
Calculus		2.18	0.51–9.10	0.300
≤60%	107			
>60%	8			
†Sextants with code 3 or 4		1.14	0.52–2.48	0.743
No	60			
Yes	55			
‡DM years		0.89	0.30–2.62	0.831
≤10 years	17			
>10 years	98			
Complications		1.15	0.52–2.51	0.734
No	51			
Yes	64			
$HbA1_c$ value		0.84	0.37–1.90	0.681
≤8.5%	72			
≥8.6%	42			

* Community Periodontal Index of Treatment Needs.
† At least three sextants with code 3 or one with code 4.
‡ Years with diabetes mellitus.

Table 4. Logistic regression for dependent variables: tooth-based deteriorated *CPITN score (n = 38) when changes between scores 0, 1, and 2 are not taken into consideration

	Dependent variable				
Independent variables	B	SE	OR	95% CI	*P*
Tooth-based deteriorated CPITN score					
Age ≥40 years	0.05	0.50	1.05	0.40–2.76	0.926
Male	0.81	0.50	2.23	0.84–6.05	0.106
High education	0.22	0.48	1.24	0.49–3.18	0.650
No smoking	−1.12	0.54	0.33	0.11–0.94	0.038
Dental visits <1 year ago	−0.79	1.49	0.46	0.17–1.20	0.111
Brushing ≥2 × day	0.47	0.54	1.60	0.56–4.61	0.382
Interdental cleaning ≥1 × day	−1.36	0.62	0.26	0.08–0.86	0.028
Calculus >60%	1.16	0.93	3.19	0.52–19.60	0.211
†Sextants with code 3 or 4	0.30	0.47	1.35	0.54–3.37	0.523
Duration of diabetes >10 years	−0.05	0.67	0.95	0.26–3.54	0.953
Complications	−0.08	0.48	0.92	0.36–2.35	0.923
$HbA1_c$ value ≥8.6%	−0.26	0.50	0.78	0.29–2.07	0.775

* Community Periodontal Index of Treatment Needs.
† At least three sextants with code 3 or one with code 4.

Factors related to changes in the CPITN index

Because in the baseline Pearson chi-squared test fewer variables were associated with improvement of the individual tooth-based CPITN index (codes 3 and 4) than with deterioration of that index, the latter was chosen to be the variable for further reporting. Self-reported antibiotic use during the 6 months prior to the examination in 2001 was not associated with either improvement or deterioration of the index in the baseline analysis as well as the type of diabetes.

Factors significantly associated with a higher tooth-based CPITN index (codes 3 or 4) included smoking, infrequent dental visits, and infrequent interdental cleaning (Table 3). When factors were examined independently in logistic regression analysis in Table 4, smoking and infrequent interdental cleaning remained significant.

Discussion

The CPITN is recommended for evaluation of long-term results of preventive and treatment efforts (14). In several countries, this index is used for detecting changes in periodontal health (15). Consistent with Lennon et al. (16), we found that the CPITN index, based on the highest CPITN code for the mouth, is insensitive to change even when changes in plaque and calculus indices were significant. We could, however, detect changes in periodontal treatment needs in the tooth-based individual CPITN index, which was used to assess risk factors for increased treatment needs.

Increased periodontal treatment needs were studied in more detail. Not unexpectedly, our results indicated that periodontal health could be promoted by encouraging the cessation of smoking. Moore et al. (17) found that smoking increased the likelihood of developing periodontal disease almost 10-fold (OR 9.73; 95% CI 4.40–22.4) among patients with type 1 diabetes. The risk for periodontal disease was significantly higher for smokers with diabetes than for any other group (smoking, non-diabetic; non-smoking, diabetic; and non-smoking, non-diabetic) (18). Moreover, smokers have a less favorable response to both non-surgical and surgical periodontal therapies (19).

The importance of regular interdental cleaning in maintaining periodontal health was emphasized in the final regression model. A Norwegian study examining deterioration of the Periodontal Treatment Need System (PTNS) index also demonstrated that lack of interdental cleaning and low educational level were the main factors associated with an increased number of quadrants with deep periodontal pockets (20).

Infrequent dental visits were another factor significantly associated with deterioration of the individual tooth-based CPITN index (codes 3 or 4). Although the role of frequent dental visits in good periodontal health is controversial (21), among individuals with diabetes who are already at risk because of their systemic disease the importance of regular dental visits is indisputable (17, 22).

No study to date has been able to induce periodontal disease in the individual with diabetes without the local factors of plaque and calculus (23). In addition, prevention and control of gingivitis will prevent periodontitis and maintain periodontal health (4). This was also concluded by Axelsson et al. (24), who demonstrated that preventing plaque accumulation with a variety of professional and home-based techniques was extremely effective in impeding attachment loss over a period of 15 years in the general Swedish population. Also CPITN scores, which were calculated for each individual tooth surface, indicated a marked decrease in periodontal treatment needs (24).

While the diabetic state cannot be modified, diabetes mellitus can be considered to be a modifiable risk indicator. Among patients with diabetes, poor glycemic control (25, 26) and other organ complications (27)

increase the risk for periodontal disease. The risk for severe periodontitis in well-controlled patients with diabetes, especially those without calculus and with excellent dental care and oral hygiene, is no greater than in patients without diabetes (22), and under these conditions the response to periodontal therapy is as good as in individuals without diabetes (28). In the present study, diabetes-related risk factors did not prove to be significant in explaining deterioration of the individual tooth-based CPITN index.

Although some increase did occur in all oral health habits among the study population between 1999 and 2000, the low rates of those individuals with a twice-a-day tooth brushing habit (34%) and daily interdental cleaning (29%) call for additional prevention strategies. The rate of those claiming to brush their teeth more often than once a day (34%) was considerably lower than that reported by Murtomaa et al. (61%) (29). Moreover, a remarkably high number of individuals had needed urgent dental care. Today, instruction and motivation of patients with regular visits to the dental office and professional feedback and reinforcement seem to be the most successful approaches in preventing periodontal relapse and disease progression (30). Dental professionals should, however, be aware of the diabetic state of their patients and take a more active role in promoting oral self-care, which might also have a positive effect on patients' general health.

The common risk factor approach (1) could be applied to alleviate multiple risks in oral health. All healthcare professionals share the responsibility of minimizing risk factors for increased periodontal treatment needs. Cigarette smoking is a modifiable risk factor that continues to challenge health promotion programs. Comprehensive personal and professional oral hygiene is an essential factor in promoting periodontal health among patients with diabetes, not underestimating the significance of the disease itself as a risk factor for periodontal disease.

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