Journal of Clinical Periodontology
Official Journal of The European Federation of Periodontology
Founded by the British, Dutch, French, German, Scandinavian, and Swiss Societies of Periodontology

J Clin Periodontol 2009; 36: 51–57 doi: 10.1111/j.1600-051X.2008.01343.x

Resolution of periodontal inflammation does not guarantee improved glycemic control in type 1 diabetic subjects

Tellervo Tervonen[1,2], Sari Lamminsalo[1], Liisa Hiltunen[3,4], Taina Raunio[1,5] and Matti Knuuttila[1,2]

[1]Department of Periodontology and Geriatric Dentistry, Institute of Dentistry, University of Oulu, Oulu, Finland; [2]Oral and Maxillofacial Department, Oulu University Hospital, Oulu, Finland; [3]Department of General Practice, Oulu University Hospital, Oulu, Finland; [4]Department of Health Sciences, University of Oulu, Oulu, Finland; [5]The Special Oral Health Care Unit, City of Oulu, Oulu, Finland

Tervonen T, Lamminsalo S, Hiltunen L, Raunio T, Knuuttila M. Resolution of periodontal inflammation does not guarantee improved glycemic control in type 1 diabetic subjects. J Clin Periodontol 2009; 36: 51–57. doi: 10.1111/j.1600-051X.2008.01343.x.

Abstract

Objective: The aim of this study was to find out if periodontal therapy has any effect on glycemic control of type 1 diabetes mellitus (DM).

Subjects and Methods: The periodontal health status of 65 type 1 diabetic subjects was assessed at the baseline and 8 weeks after completion of periodontal therapy. Glycemic control was assessed on both visits by measuring the percentage of glycosylated haemoglobin (GHbA1c). The change in HbA1c (ΔHbA1c) was assessed by using both a positive or negative change $\geqslant$0.5% and any change in HbA1c.

Results: The mean HbA1c level (± SD) of the whole study group was 8.6% (± 1.5) at the baseline and 8.5% (± 1.5) after treatment. Glycemic control improved during the study period in 23 subjects (35%) and worsened in 18 subjects (28%). Approximately 78% of the bleeding sites and 87% of the sites with probing depth $\geqslant$4 mm presented healing. ΔHbA1c associated significantly with baseline HbA1c but not with baseline periodontal health status or periodontal healing.

Conclusion: Regardless of a significant resolution of periodontal infection, a great majority of the subjects did not present any improvement in their glycemic control.

Key words: glycemic control; periodontal disease; periodontal healing; periodontal therapy; type 1 diabetes mellitus

Accepted for publication 28 September 2008

It has been suggested that a two-way relationship exists between diabetes mellitus (DM) and periodontal disease. Accordingly, DM is a known risk factor of periodontal disease (Cianciola et al. 1982, Taylor et al. 1998, Salvi et al. 2005, Lalla et al. 2007) but, also vice versa, periodontal disease may complicate the severity of diabetes by worsening the degree of glycemic control (Grossi & Genco 1998, Donahue & Wu 2001, Nishimura et al. 2003).

The results of studies on the effect of periodontal therapy on glycemic control of DM are conflicting. A number of studies indicate that glycemic control can be improved by non-surgical periodontal treatment, especially when combined with systemic antimicrobial therapy (Miller et al. 1992, Grossi et al. 1996, 1997, Iwamoto et al. 2001, Stewart et al. 2001, Skaleric et al. 2004, Navarro-Sanchez et al. 2007). However, based on a meta-analysis of 10 studies involving 456 type 1 and type 2 diabetics, Janket et al. (2005) concluded that there is no evidence strong enough to indicate that periodontal treatment would affect glycemic control in diabetic patients. In line with the previous studies, the results of a recent, randomized, controlled clinical trial among poorly controlled type 2 patients done by Jones et al. (2007) revealed no significant benefit of periodontal therapy after 4 months.

A vast majority of studies investigating the effect of periodontal therapy on glycemic control have been conducted among type 2 diabetic subjects. One conclusion drawn from the meta-analysis by Janket et al. (2005) was that stronger effects of periodontal treatment on HbA1c levels were observed in studies investigating type 2 DM when compared with studies that examined predominantly type 1 DM group. The recommendation of the group is that

Conflict of interest and source of funding statement

The authors declare that there is no conflict of interests.
The financial support from the Finnish Dental Society Apollonia is appreciated.

future studies should be limited to type 2 patients. There are also studies in which both type 1 and type 2 diabetic subjects have been included (Westfelt et al. 1996, Christgau et al. 1998, Al-Mubarak et al. 2002).

Since the first report of the effect of periodontal therapy on diabetes control by Williams & Mahan (1960), only a few studies have been made that exclusively cover type 1 diabetic subjects. Among these is the pilot study of nine subjects with insulin-dependent diabetes mellitus (IDDM) conducted by Miller et al. (1992). The authors reported that metabolic control of diabetic patients with moderate to severe periodontitis could be altered by controlling their periodontal inflammation. In line with this, Skaleric et al. (2004) report a decrease in HbA1c levels in type 1 diabetic subjects after periodontal therapy. However, despite significant improvement in periodontal health status after non-surgical periodontal therapy, no significant improvement in HbA1c levels have been observed in other studies (Seppälä & Ainamo 1994, Alridge et al. 1995, Smith et al. 1996). A closer inspection of the above studies reveals that there is great variation in the severity of both periodontal and diabetic status between the studies. No definite conclusions can therefore be drawn on the effect of periodontal treatment on glycemic control in type 1 diabetic patients, and a need for further studies still remains.

In 2001–2006, we examined the periodontal health status and glycemic control of a group of type 1 diabetic subjects (Raunio et al. 2008) attending a primary health care diabetes unit. Their periodontal health status and the level of glycemic control were re-examined after completion of periodontal therapy. The aim of the present study was to investigate the effect of improved periodontal health on glycemic control of type 1 DM.

Material and Methods

The study protocol was approved by the ethical committee of Oulu University Hospital and an informed consent form was signed by all the subjects.

Design

The subjects of the present study were examined clinically at the baseline, then treated periodontally and re-examined after the treatment. The length of the treatment period was on average 15.4 weeks. The follow-up examination was performed approximately 8 weeks after completion of the therapy. To assess the level of glycemic control (HbA1c), blood samples were taken at the baseline and in the follow-up examination. In the longitudinal setting of the study, the subjects served as their own controls.

Subjects

Originally, 80 diabetic subjects with type 1 DM, mainly from the Diabetes Clinic of Oulu Health Center, volunteered to participate in our main study of periodontal disease and type 1 DM (Raunio et al. 2008). Fifteen of them were either unwilling to continue the study, moved to another locality or had no need for periodontal therapy at the time of the baseline examination (two subjects), leaving a total of 65 subjects to participate in the present study.

Subjects needing prophylactic antibiotic medication in association with periodontal probing as well as those with immunosuppressive medication were excluded. None of the subjects were/had been on antibiotics at the time of the baseline examination or 4 months before it. Data concerning smoking were obtained by interview and the subjects were categorized as smokers and non-smokers.

Periodontal variables

The following periodontal variables were examined by the same specialist in periodontology (T. R.) in both examinations: visible plaque corresponding to scores 2 and 3 of the Sillness & Löe (1964) plaque index, probing pocket depth (PD) from gingival margin to the base of the crevice/pocket, bleeding on probing (BOP) 20–30 s after probing and attachment level (AL) from the cemento-enamel junction to the base of the crevice/pocket (Table 1). The measurements were performed on four surfaces of each tooth (mesiobuccal, midbuccal, distobuccal and midpalatal/lingual) and the extent of periodontal disease was expressed as mean percentages of affected sites out of the total number of sites measured. ΔBOP, $\Delta PD \geqslant 4$ mm and $\Delta PD \geqslant 6$ mm, i.e. the difference in the extent of sites with BOP, $PD \geqslant 4$ mm and $PD \geqslant 6$ mm between the baseline and the follow-up examination were calculated to indicate periodontal healing. A median of $\Delta PD \geqslant 4$ mm was used to divide the subjects into two categories of healing response: those below the median belonging to the ''moderate response'' group and those above the median belonging to the ''good response'' group (Table 2).

Periodontal therapy

The anti-infective periodontal therapy consisted of oral hygiene education, scaling and root planing and periodontal surgery whenever indicated. With clinical periodontal health as the goal, periodontal treatment was performed according to principles used in the university hospital clinic by a team including a dental hygienist, specializing dentists and a senior periodontist (T. T.). Periodontal healing was monitored during the treatment phase by observing PD and BOP, and registering residual calculus/root surface roughness, and treatment was continued until adequate periodontal healing could be observed. A follow-up examination was scheduled approximately 8 weeks after completion of the treatment.

Based on microbial culture analysis of *Porphyromonas gingivalis*, *Actinobacillus actinomycetemcomitans*, *Prevotella intermedia/nigrescens*, *Tannerella forsythia*, *Micromonas micros* and *Campylobacter rectus*, systemic antibiotics were prescribed to eight patients in conjunction with the therapy. The following antibiotics were used: doxycycline, metronidazol, amoxicillin, amoxicillin/clavulanic acid, ciprofloxacin, clindamycin and azitromycin. In addition, one elderly patient with severe diabetic complications received penicillin to support wound healing in association with a tooth extraction and a surgical flap procedure.

Diabetes status

The blood samples of both examinations were analysed for glycosylated haemoglobin (HbA1c, %) in the same laboratory using immunoassay methods. ΔHbA1c (%) was calculated to indicate any change in the actual HbA1c value from the baseline to the follow-up examination. The range of ΔHbA1c (%) was from -2.7 to $+2.8$ (Fig. 1). In addition, a $\geqslant 0.5\%$ decrease or increase in HbA1c between the baseline

Table 1. Characteristics of the subjects in the whole study group ($n = 65$) and separately in subjects with a decrease in HbA1c, with stable GHbA1c and with an increase in GHbA1c between the baseline and the follow-up examination

	All subjects ($n = 65$)	Decrease in HbA1c ($n = 23$)	Stable HbA1c ($n = 24$)	Increase in HbA1c ($n = 18$)
Age (years, mean ± SD)	40.0 ± 12.8	38.6 ± 13.2	37.8 ± 11.3	44.6 ± 13.9
Range	18.6–74.4	18.6–64.4	23.3–60.7	22.4–74.4
Females (*n*)	38	14	12	12
Smokers (*n*)	10	2	3	5
Diabetes variables				
HbA1c (%, mean ± SD)				
Baseline	8.6 ± 1.4	9.3 ± 1.3	8.2 ± 1.4	8.1 ± 1.2
Follow-up	8.5 ± 1.4	8.3 ± 1.2	8.2 ± 1.5	9.2 ± 1.4
Duration of DM (years, mean ± SD)	20.1 ± 12.4	17.9 ± 11.2	19.0 ± 11.8	24.3 ± 14.1
Range	1.2–48.1	1.6–43.5	1.2–42.6	4.2–48.1
Complications of DM present (*n*)	41	13	14	14
Periodontal variables (mean percentage of sites/subject ± SD)				
Plaque	30.4 ± 23.7	31.2 ± 24.6	30.8 ± 22.6	28.8 ± 25.4
BOP	68.7 ± 14.7	69.6 ± 14.4	66.2 ± 14.8	70.9 ± 15.3
PD ⩾ 4 mm	24.0 ± 20.2	27.7 ± 22.5	19.8 ± 18.6	24.7 ± 19.4
PD ⩾ 6 mm	3.0 ± 8.6	4.4 ± 12.2	2.2 ± 7.0	2.3 ± 4.2
AL ⩾ 4 mm	13.3 ± 23.6	14.6 ± 26.3	11.4 ± 22.3	14.3 ± 22.8
AL ⩾ 6 mm	4.4 ± 12.5	4.9 ± 11.2	3.5 ± 11.4	4.9 ± 15.9
ΔBOP	54.5 ± 17.8	51.7 ± 16.9	55.0 ± 18.5	57.6 ± 18.6
ΔPD ⩾ 4 mm	20.5 ± 16.9	23.7 ± 19.0	17.0 ± 15.2	21.1 ± 16.2
ΔPD ⩾ 6 mm	2.9 ± 8.1	4.4 ± 12.0	1.8 ± 5.4	2.3 ± 4.2

Only a ⩾0.5% increase or decrease was considered a change, otherwise the level of glycemic control was considered stable.
DM, diabetes mellitus; PD, probing pocket depth; BOP, bleeding on probing; AL, attachment level.

Table 2. Mean levels (± SD) of HbA1c (%) at the baseline and after periodontal therapy and changes in HbA1c levels between the baseline and the follow-up examination by control of DM, periodontal healing response (ΔPD ⩾ 4 mm) and severity of periodontitis

	HbA1c Baseline	HbA1c After therapy	Decrease in HbA1c *n* (%)	Stable HbA1c *n* (%)	Increase in HbA1c *n* (%)
Baseline control of DM					
Good (HbA1c < 8.5%, $n = 30$)	7.3 ± 0.8	7.5 ± 1.0	7 (23.3)	12 (40.0)	11 (36.7)
Poor (HbA1c ⩾ 8.5%, $n = 35$)	9.6 ± 0.9	9.3 ± 1.2	16 (45.7)	12 (34.3)	7 (20.0)
Severity of periodontitis at baseline					
Early (PD ⩽ 5 mm, $n = 44$)	8.3 ± 1.3	8.2 ± 1.3	14 (31.8)	19 (43.2)	11 (25.0)
Advanced (PD ⩾ 6 mm, $n = 21$)	9.2 ± 1.5	9.0 ± 1.6	9 (42.9)	5 (23.8)	7 (33.3)
*Periodontal healing (ΔPD ⩾ 4 mm)**					
Good ($n = 32$)	8.0 ± 1.2	8.0 ± 1.2	8 (25.0)	15 (46.9)	9 (28.1)
Moderate ($n = 33$)	9.1 ± 1.4	8.9 ± 1.5	15 (45.5)	9 (27.3)	9 (27.3)

Only a ⩾0.5% increase or decrease from the baseline to the follow-up examination was considered a change, otherwise the level of glycemic control was considered stable.
*The median value of ΔPD ⩾ 4 mm was used as a cut-off point between the groups.
DM, diabetes mellitus; PD, probing pocket depth.

and the follow-up examination was recorded as an improvement or worsening of glycemic control (Tables 1, 2 and 4). Lack of such change was considered ''stable HbA1c''. A regression analysis was used to study possible associations between ΔHbA1c and periodontal healing (ΔBOP, ΔPD ⩾ 4 mm and ΔPD ⩾ 6 mm), baseline periodontal health status and baseline HbA1c (Table 3).

Patient records were used to evaluate individual variation in glycemic control before the study period (pre-intervention HbA1c levels, Table 4). For this purpose, a period corresponding in length to the actual study period (23 weeks on average) was chosen. These data were available for 60 subjects and included HbA1c measurements made either in the hospital laboratory or in the unit using a simple and quick method utilizing monoclonal antibody agglutination reaction (DCA, Siemens, Eschorn, Germany).

Data concerning the year of onset of DM and the presence of retinopathy (proliferative or non-proliferative), nephropathy (micro- or macro-albuminuria), neuropathy and macro-vascular complications (stroke, myocardial infarction) were retrieved from patient records.

Most of the subjects of the present study visited the same primary care diabetes unit and were treated by the same specialist in diabetology (L. H.). However, a few patients were occasionally treated in the university hospital's eye and kidney clinics. Regular treatment of type 1 DM according to the

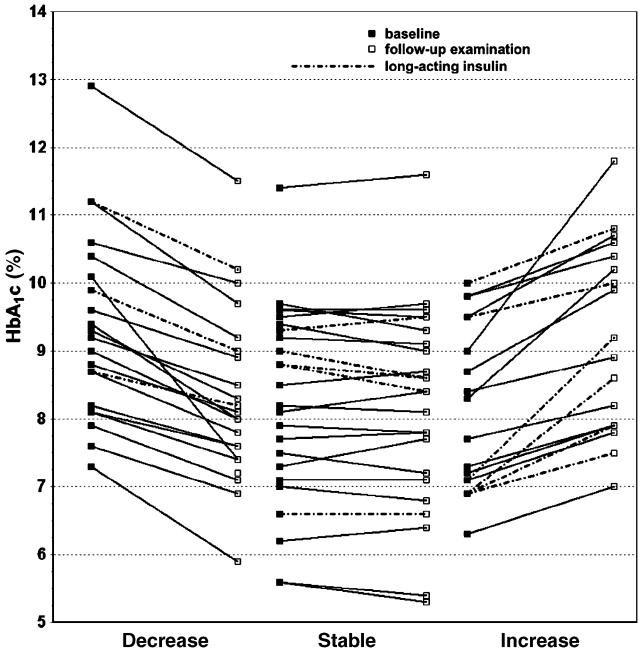

Fig. 1. Subject level changes in HbA1c levels between the baseline and the follow-up examination. A ⩾ 0.55% increase or decrease was considered a change, otherwise the level of glycemic control was considered stable. Subjects for whom a long-acting insulin treatment was started are indicated separately.

Table 3. Age and smoking-adjusted associations between ΔHbA1c (%) and periodontal healing (ΔBOP, ΔPD⩾4 mm andΔPD⩾6 mm), baseline HbA1c (%) and baseline extent of BOP, PD⩾4 mm and PD⩾6 mm

	β	95% CI for β	*p*-value
ΔBOP	0.001	− 0.019–0.022	0.892
Baseline HbA1c	− 0.227	− 0.391– − 0.062	0.008
Baseline BOP*	− 0.002	− 0.026–0.023	0.894
ΔPD⩾4 mm	0.008	− 0.047–0.064	0.765
Baseline HbA1c	− 0.194	− 0.354– − 0.035	0.018
Baseline PD⩾4 mm*	− 0.019	− 0.065–0.028	0.428
ΔPD⩾6 mm	− 0.112	− 0.363–0.138	0.373
Baseline HbA1c	− 0.181	− 0.335– − 0.028	0.021
Baseline PD⩾6 mm*	0.069	− 0.166–0.304	0.559

*Extent/percentages of affected sites per person.
BOP, bleeding on probing; PD, probing pocket depth.

Table 4. Cross-tabulation of changes in HbA1c levels during the study period and during a selected period before the study (pre-intervention HbA1c levels)

Pre-intervention HbA1c levels	HbA1c levels during the study period			
	decrease	stable	increase	total
Decrease	1	6	5	12 (20.0)
Stable	14	10	8	32 (53.3)
Increase	6	6	4	16 (26.7)
Total	21 (35.0)	22 (36.7)	17 (28.3)	60 (100.0)

Only a ⩾0.5% increase or decrease from the baseline to the follow-up examination was considered a change, otherwise the level of glycemic control was considered stable.

guidelines of the Finnish Diabetes Association for the treatment of type 1 DM was delivered in the primary health care unit. Changes in insulin doses were registered for the 14 diabetics whose treatment regimen was supplemented with a new long-acting insulin (glargi-nin) during the study period or ⩽6 months before the baseline examination (Fig. 1).

Results

There were altogether 38 females and 27 males with a mean age of 40.0 (± 12.8) years and with a mean diabetes duration of 20.1 (± 12.4) years (Table 1). The mean HbA1c level of the whole group was 8.6% (± 1.4) at the baseline and 8.5% (± 1.4) after periodontal therapy. Diabetic complications were present in 41 subjects.

At the baseline, two subjects presented BOP but no sites with PD⩾4 mm. One third (36.9%) of the subjects had PD⩾4 mm on ⩾30% of the sites, and 32.3% had at least one site with PD⩾6 mm. A total of 33.8% of the subjects presented at least one site with AL⩾6 mm. BOP was recorded on a total of 68.7% of the sites per subject, and 24.0% and 3.0% of the sites presented PD⩾4 mm and PD⩾6 mm, respectively (Table 1). Excellent healing of deepened periodontal pockets occurred as indicated by ΔBOP of 54.5%, ΔPD⩾4 mm of 20.5% and ΔPD⩾6 mm of 2.9%.

An improvement in glycemic control after periodontal therapy was observed in 23 subjects (35.4%), a stable level in 24 subjects (36.9%) and a worsening in 18 subjects (27.7%) (Fig. 1). Comparisons of these subgroups with respect to their demographics, diabetes and periodontal data are presented in Table 1. While the HbA1c level of the nine subjects who received a systemic antibiotic in conjunction with the therapy remained stable in one subject, four of them presented a decrease and another four an increase in HbA1c level.

The mean HbA1c level of the subjects presenting an improvement in glycemic control was 9.3% at the baseline and 8.3% after periodontal therapy. Respectively, a change from 8.1% to 9.2% was observed in subjects presenting a worsening in their glucose control. The periodontal health status of the subjects and healing of periodontal infection were similar in the three groups. Altogether, three of the subjects presenting an improvement in their glycemic control and six of those with worsening glycemic control were started on a new long-acting insulin (Fig. 1).

Stratification of the subjects by the baseline level of glycemic control, the baseline severity of periodontal disease

and healing response indicated that subjects with good control, early periodontal disease and good healing response presented lower HbA1c levels when compared with those with poor control, advanced periodontal disease and only moderate healing response (Table 2). The changes in the mean values of HbA1c from the baseline to the follow-up examination were very small in each group. As regards to individual changes in glycemic control, there were relatively more subjects whose control improved among those with poor control of DM (45.7%), advanced periodontal disease (42.9%) and only moderate healing response (45.5%) than there were among those with good control (23.3%), early periodontal disease (31.8%) and good healing response (25.0%). Subjects with good control of DM, early periodontal disease and good healing response were more likely to have stable HbA1c during the study period.

The estimates of the regression models used to study the associations between ΔHbA1c and its determinants are shown in Table 3. After adjusting for age, smoking, baseline HbA1c and baseline extent of periodontal disease, no statistically significant associations were found between ΔHbA1c and periodontal healing. In each of the three models, baseline HbA1c turned out to be a significant determinant of ΔHbA1c.

The analysis of the overall stability of the level of glycemic control was performed by cross-tabulating the changes in glycemic control during a period before the study and the present study period (Table 4). There were more subjects with an improvement in control during the present study than during the pre-intervention period (35.0% *versus* 20.0%) and less of those whose control remained stable (36.7% *versus* 53.3%). There were only 10 subjects whose glycemic control remained stable during both periods.

Discussion

The main result of the present study is that regardless of a significant resolution of periodontal infection, a great majority of the subjects did not present significant improvement in their glycemic control. The subject-level variation in glycemic control, as indicated by changes greater than or equal to ± 0.5% of the HbA1c levels, was most evident (Fig. 1, Table 4). However, the variation was not related to either baseline periodontal health status or periodontal healing (Tables 1–3). The only variable associating significantly with ΔHbA1c was baseline HbA1c (Table 3).

We chose to analyse the mean values (± SD) of HbA1c, ΔHbA1c and the decreases/increases in HbA1c to get a more relevant picture of possible changes in glycemic control. The cut-off point for the change in HbA1c value (± 0.5%) was arbitrarily chosen to minimize the effect of method-related errors in HbA1c laboratory analysis. Accordingly, an improvement in glycemic control was observed in 35% of the subjects, but during the same period, control worsened in 28% (Table 1). Miller et al. (1992) reported improvement in glycemic control along with a consistent decrease in bleeding scores in five of their nine IDDM patients, whereas in the remaining studies among type 1 diabetic subjects (Seppälä et al. 1993, Alridge et al. 1995, Skaleric et al. 2004), no patient-level changes have been reported. Using reductions of 0.5% and 1% in HbA1c levels, Jones et al. (2007) found that 52% and 34% of their subjects presented improvement in glycemic control after periodontal therapy. Patients with type 2 diabetes treated periodontally by Stewart et al. (2001) presented an overall improvement of 17.1% in HbA1c values. However, a patient-level inspection revealed that while a vast majority of the subjects (27 out of 36 subjects) in the treatment group improved their glycemic control, there were also five subjects with no change and four subjects whose glycemic control worsened. In the untreated control group, glucose control worsened in 10 subjects, remained stable in another 10 and improved in 16 subjects. These results together with the current findings thus clearly indicate that fluctuation in HbA1c levels is evident and the benefits of periodontal therapy are not necessarily reflected in HbA1c levels. Based on the results of the present study, no conclusions can be drawn on whether or not the elimination of periodontal infection had other beneficial effects on the diabetes status. Therefore, future longitudinal studies are needed to investigate other outcomes of periodontal therapy, including effects on the development and progression of systemic complications of DM and changes in the level of systemic inflammation.

The pathogenic mechanisms in type 1 and type 2 diabetes are quite different, which may have an effect on the risk of periodontal disease as well as on other co-morbidities in the two groups of patients. In addition, the treatment strategies differ between the two types and, apparently, the outcomes of periodontal therapy are also different and should be assessed separately in these two patient categories (Janket et al. 2005, Lalla 2007). Among the factors contributing to the variation in glycemic control in type 1 DM are insulin dose, diet and exercise. It has been speculated that due to tight monitoring of glucose levels and adjustment of insulin doses in type 1 DM, improvement in glycated haemoglobin level after periodontal therapy may be more difficult to achieve (Janket et al. 2005, Lalla 2007). Based on the usual recommendations for type 1 diabetic patients, the subjects of the present study were advised to adjust their meal insulin doses according to carbohydrates, and although no benefit of periodontal therapy to glycemic control was observed on the practical level, we cannot fully ignore that a minor decrease in glucose levels occurred in some subjects. This point was addressed in the very early reports by Williams & Mahan (1960) and Wolff (1977), who report lower blood and urine glucose levels as well as lower needs for insulin after periodontal therapy and extraction of infectious teeth.

A significant resolution of periodontal infection was seen in the present subjects (Table 1). This is one of the strengths of our study when compared with previous studies in which infection seems to remain in a number of sites at the time of re-examination (Miller et al. 1992, Alridge et al. 1995, Smith et al. 1996, Skaleric et al. 2004). In reporting the effect of periodontal therapy on glycemic control among type 2 diabetic subjects after 4 months, Jones et al. (2007) consider this point and suggest that more complete periodontal healing results could obviously be seen after 12 months. The length of the follow-up period is an important issue also with regard to changes in HbA1c levels. As the follow-up examination was scheduled approximately 8 weeks after the completion of periodontal therapy, the recommended minimum length 2-month follow-up (Janket et al. 2005) was reached in our study. However, the actual length of the follow-up in this study may be considered longer than 8

weeks in the sense that gradual healing of periodontal infection obviously occurred in most patients during the entire treatment period (15.4 weeks, on average).

Systemic antibiotics in conjunction with periodontal therapy have been shown to amplify improvement in glycemic control (Grossi 2001). The finding that four subjects who received antibiotics in conjunction with the therapy presented improved HbA1c levels and another four decreased HbA1c levels does not support the above.

The interpretation of our results is complicated by some factors. Introduction of new long-acting insulins at the same time with our data gathering may have influenced the HbA1c change. We considered long-acting insulins (Fig. 1) if they were administered during the study period or $\leqslant$6 months before it. In practice, administration of new insulin was started cautiously, e.g. with doses that were obviously not high enough, and this may be one reason for the increases in HbA1c in some subjects. Secondly, while the HbA1c levels both at the baseline and after periodontal therapy were measured in the same laboratory, the pre-intervention values were measured partly in the laboratory and partly in the unit using DCA (Table 4). It is possible that the method-related difference between the two measurements may cause some inaccuracy in the result concerning the pre-intervention period.

We did not perform statistical power calculations of the sample size, and one of the shortcomings of this study is that, due to the small number of patients it is underpowered, a fact that absolutely holds true for all the previous studies among type 1 diabetics. As regards the size of the sample, even Jones et al. (2007) after conducting the largest study among type 2 patients and using a feasible sample size of 165 subjects consider their study as underpowered. They suggest that a total of 362 subjects per group would be needed to detect a 10% difference in the proportion of subjects with improvement of at least 1% in HbA1c between periodontally treated and untreated subjects. The *post hoc* calculations by Janket et al. (2005) indicate that at least 246 participants would be needed to observe a 10% reduction in HbA1c (0.7% in actual value of HbA1c) with 90% power after periodontal therapy. Regardless of the fact that periodontal therapy has been demonstrated to have favourable effects on metabolic control of type 2 diabetic subjects, large-scale multi-centre clinical trials are needed to confirm the current evidence. As only around 10% of diabetics are of type 1, a special challenge exists in recruiting a large enough sample of type 1 diabetic subjects.

Although the results of the present study should be interpreted with caution due to the fairly small sample size, they add to the current knowledge of the effect of periodontal therapy on glycemic control in type 1 diabetic patients. Within the limitations of the study, we conclude that great inter-individual variation occurred in the response to periodontal therapy when measured as a change in the level of glycemic control. Resolution of periodontal infection did not necessarily result in improved glycemic control. Regardless of this result, periodontal treatment of type 1 diabetic subjects should not be neglected. The good response to anti-infective periodontal treatment observed here holds promise in maintaining periodontal health and functional occlusion in type 1 diabetic subjects.

References

Al-Mubarak, S., Ciancio, S., Aljada, A., Awa, H., Hamouda, W., Ghanim, H., Zambon, J., Boardman, T. J., Mohanty, P., Ross, C. & Dandona, P. J. (2002) Comparative evaluation of adjunctive oral irrigation in diabetics. *Journal of Clinical Periodontology* **29**, 295–300.

Alridge, J. P., Lester, V., Watts, T. L. P., Collins, A., Viberti, G. & Wilson, R. F. (1995) Single-blind studies of the effects of improved periodontal health on metabolic control in Type 1 diabetes mellitus. *Journal of Clinical Periodontology* **22**, 271–275.

Christgau, M., Palitzsch, K. D., Schmalz, G., Kreiner, U. & Frenzel, S. (1998) Healing response to non-surgical periodontal therapy in patients with diabetes mellitus: clinical, microbiological, and immunologic results. *Journal of Clinical Periodontology* **25**, 112–124.

Cianciola, L. J., Park, B. H., Bruck, E., Mosovick, L. & Genco, R. J. (1982) Prevalence of periodontal disease in insulin-dependent diabetes mellitus (juvenile diabetes). *Journal of American Dental Association* **104**, 653–660.

Donahue, R. T. & Wu, T. (2001) Insulin resistance and periodontal disease: an epidemiologic overview of research needs and future directions. *Annals of Periodontology* **6**, 199–224.

Grossi, S. G. & Genco, R. J. (1998) Periodontal disease and diabetes mellitus: two-way relationship. *Annals of Periodontology* **3**, 51–61.

Grossi, S. G. (2001) Treatment of periodontal disease and control of diabetes: an assessment of the evidence and need for future research. *Annals of Periodontology* **6**, 138–145.

Grossi, S. G., Skrepcinski, F. B., DeCaro, T., Robertson, D. C., Ho, A. W., Dunford, R. G. & Genco, R. (1997) Treatment of periodontal disease in diabetics reduces glycated hemoglobin. *Journal of Periodontology* **68**, 713–719.

Grossi, S. G., Skrepcinski, F. B., DeCaro, T., Zambon, J. J., Cummins, D. & Genco, R. J. (1996) Response to periodontal therapy in diabetics and smokers. *Journal of Periodontology* **67**, 1094–1102.

Iwamoto, Y., Nishimura, F., Nakagawa, M., Sugimoto, H., Shikata, K., Makino, H., Fukuda, T., Tsuji, T., Iwamoto, M. & Murayama, Y. (2001) The effect of antimicrobial periodontal treatment on circulating tumor necrosis factor-alpha and glycated hemoglobin level in patients with type 2 diabetes. *Journal of Periodontology* **72**, 774–778.

Janket, S. J., Wightman, A., Baird, A. E., Van Dyke, T. E. & Jones, J. A. (2005) A meta-analysis of periodontal treatment on glycemic control. *Journal of Dental Research* **85**, 1154–1159.

Jones, J. A., Miller, D. R., Wehler, C. J., Rich, S. E., Krall-Kaye, E. A., McCoy, L. C., Christiansen, C. L., Rothendler, J. A. & Garcia, R. I. (2007) Does periodontal care improve glycemic control? The department of veterans affairs dental diabetes study. *Journal of Clinical Periodontology* **34**, 46–52.

Lalla, E. (2007) Periodontal infections and diabetes mellitus: when will the puzzle be complete? *Journal of Clinical Periodontology* **34**, 913–916.

Lalla, E., Cheng, B., Lal, S., Kaplan, S., Softness, B., Greenberg, E., Goland, R. S. & Lamster, I. B. (2007) Diabetes mellitus promotes periodontal destruction in children. *Journal of Clinical Periodontology* **34**, 294–298.

Miller, L. S., Manwell, M. A., Newbold, D., Reding, M. E., Rasheed, A., Blodgett, J. & Kornman, K. (1992) The relationship between reduction in periodontal inflammation and diabetes control: a report of 9 cases. *Journal of Periodontology* **63**, 843–848.

Navarro-Sanchez, A. B., Faria-Almeida, R. & Bascones-Martinez, A. (2007) Effect of non-surgical periodontal therapy on clinical and immunological response and glycaemic control in type 2 diabetic patients with moderate periodontitis. *Journal of Clinical Periodontology* **34**, 835–843.

Nishimura, F., Iwamoto, Y., Mineshiba, J., Shimizu, A., Soga, Y. & Murayama, Y. (2003) Periodontal disease and diabetes mellitus: the role of tumor necrosis factor-alpha in a 2-way relationship. *Journal of Clinical Periodontology* **74**, 97–102.

Raunio, T., Hiltunen, L., Knuuttila, M., Karttunen, R., Vainio, O. & Tervonen, T. (2008) IL-6 genotype as a determinant for the extent of periodontal disease in type 1 diabetics. *Journal of Clinical Periodontology* (submitted for publication) doi: 10.1111/j.1600-051x.2008.01344.x.

Seppälä, B. & Ainamo, J. (1994) A longitudinal study on insulin-dependent diabetes mellitus and periodontal disease. *Journal of Clinical Periodontology* **21**, 161–165.

Seppälä, B., Seppälä, M. & Ainamo, J. (1993) A longitudinal study of insulin-dependent diabetes mellitus and periodontal disease. *Journal of Clinical Periodontology* **20**, 161–165.

Salvi, G. E., Kandylaki, M., Troendle, A., Persson, G. R. & Lang, N. P. (2005) Experimental gingivitis in type 1 diabetics: a controlled clinical and microbiological study. *Journal of Clinical Periodontology* **32**, 310–316.

Sillness, J. & Löe, H. (1964) Periodontal disease in pregnancy (II). Correlation between oral hygiene and periodontal condition. *Acta Odontologica Scandinavica* **24**, 747–759.

Skaleric, U., Schara, R., Medvescek, M., Hanlon, A., Doherty, F. & Lessem, J. (2004) Periodontal treatment by Arestin® and its effects on glycemic control in type 1 diabetes patients. *Journal of the International Academy of Periodontology* **6/4** (Suppl.), 160–165.

Smith, G. T., Greenbaum, C. J., Johnson, B. D. & Persson, G. R. (1996) Short-term responses to periodontal therapy in insulin-dependent diabetic patients. *Journal of Periodontology* **67**, 794–802.

Stewart, J. E., Wager, K. A., Friedlander, A. H. & Zadeh, H. H. (2001) The effect of periodontal treatment on glycemic control in patients with type 1 diabetes mellitus. *Journal of Clinical Periodontology* **28**, 306–310.

Taylor, G. W., Burt, B. A. & Becker, M. P. (1998) Non-insulin dependent diabetes mellitus and alveolar bone loss progression over 2 years. *Journal of Periodontology* **69**, 76–83.

Westfelt, E., Rylander, H., Blohme, G., Jonasson, P. & Lindhe, J. (1996) The effect of periodontal therapy in diabetics. Results after 5 years. *Journal of Clinical Periodontology* **23**, 92–100.

Williams, R. C. & Mahan, C. J. (1960) Periodontal disease and diabetes in young adults. *Journal of American Medical Association* **172**, 776–778.

Wolff, J. (1977) Dental and periodontal conditions in diabetes mellitus. *Proceedings of the Finnish Dental Society* **73**, 41–44.

Address:
Tellervo Tervonen
Department of Periodontology and Geriatric Dentistry
Institute of Dentistry
University of Oulu
Box 5281
Oulu, FI-90014
Finland
E-mail: tellervo.tervonen@oulu.fi

Clinical Relevance

Scientific rationale for the study: The results of previous studies concerning the effect of periodontal therapy on glycemic control of type 1 DM are conflicting.

Principal findings: A significant resolution of periodontal inflammation was observed after anti-infective periodontal therapy. Improvement in glycemic control associated with the baseline HbA1c levels (%) but not with periodontal healing.

Practical implications: Good response to anti-infective periodontal therapy holds promise of maintaining periodontal health in type 1 diabetic subjects. A need for larger studies concerning beneficial outcomes of periodontal therapy other than improvement of glycemic control remains.