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# Investigation of periodontal status in type 1 diabetic adolescents

## ABSTRACT

***Aim*** *The purpose of this study was to evaluate the effects of type 1 diabetes and the possible role of metabolic control on the periodontal status of diabetic adolescents.*

***Materials and methods*** *Three groups of 40 patients each were examined: diabetic subjects with a good metabolic control (well controlled WC) (glycated haemoglobin HbA1c ≤ 7%) (20 males and 20 females; mean age: 14.1±1.5 years); diabetic subjects with poor metabolic control (poorly controlled PC) (glycated haemoglobin HbA1c> 7%) (20 males and 20 females; mean age: 14.5 ± 1.3 years); and patients in good general health, which constituted the control group (20 males and 20 females; mean age: 14.1±1.2 years). For each subject, a periodontal evaluation was performed and the following parameters were assessed: Plaque Index (PI), Gingival Index (GI), Bleeding on probing (BOP), Probing Depth (PD), Clinical Attachment Level (CAL).*

*Chi-square was used to compare categorical variables. Kruskal-Wallis one-way ANOVA by ranks was used to compare the quantitative variables (GBI, PD) among the 3 groups. Post-hoc comparison between pairs of groups was assessed by Wilcoxon's rank sum test, with a downward adjustment of the α level to compensate for multiple comparisons.*

***Results*** *The levels of PI in WC subjects (1.9 ± 0.8) and in PC subjects (2.1 ± 0.6) were significantly higher compared to healthy subjects in the control group (0.8 ± 0.7) (p <0.0001). Similarly, the GI in both PC (1.9 ± 0.8) and WC subjetcs (1.7 ± 0.9) was significantly higher (p <0.05) compared to controls (0.9 ± 0.8). GBI in the PC (60.2 ± 23.6%) and the WC (57.4 ± 22.5%) groups was significantly higher compared to healthy subjects (35.9 ± 18.7%) (p <0.05). The PD parameter was found significantly higher (p <0.05) in the PC group (26.7 ± 12.6%) and WC group (23.5 ± 11.3%) compared with controls (8.3 ± 6.2%). Regarding the CAL, no significant differences were found between the groups (p> 0.05). In addition, the comparisons between groups PC and WC were not statistically significant (p> 0.05).*

***Conclusions*** *Adolescents affected with type 1 diabetes show a higher level of bacterial plaque, gingival inflammation with bleeding on probing and probing depth, compared to healthy subjects. There were no significant changes with regard to the accumulation of plaque and periodontal status among diabetic patients both with good control and with poor metabolic control.*

***Keywords*** *Adolescents; Diabetes; Gingival disease; Periodontitis.*

## Introduction

Diabetes mellitus is a chronic metabolic disorder caused by an altered metabolism of carbohydrates, proteins and fats, characterised by high levels of glucose in the bloodstream [Cizza G. et al., 2012]. The incidence of diabetes is high in industrialised countries and tends to increase over the years [Tajima N. et al. 2012]. According to the IDF data, more than 387 million people are suffering diabetes (prevalence 8.3%) and in 2035 the number will increase probably to 592 million people [International Diabetes Federation, 2014].

There are two forms of diabetes: type 1 caused by the total or partial destruction of the pancreatic cells that produce insulin in response to an autoimmune reaction, while type 2 is linked to a mechanism of insulin resistance [Thomas et al., 2014].

The onset of type 1 diabetes usually occurs in childhood or adolescence and it is less common than type 2, as it includes only 5-10% of all forms [Majidi et al., 2012].

In order to avoid or reduce the symptoms and complications of diabetes, such as retinopathy, nephropathy [Ding et al., 2012] and neuropathies, it is important for the patient to maintain a good control of blood sugar, which is assessed by the measurement of glycated haemoglobin (HbA1c).

The haemoglobin, which is normally transported by red blood cells, can bind glucose proportionally to its amount in the blood. Considering that the average life of the red blood cell is of three months, the proportion of haemoglobin that binds glucose will be proportional to the amount of glucose that has circulated in that period. In diabetic patients, the value of glycated haemoglobin should be kept within 7% to be considered in good metabolic control [Inzucchi, 2012].

The existence of a correlation between periodontal disease and diabetes mellitus is described in the literature [Taylor, et al., 2008]; in particular, diabetes seems to be more a predisposing factor rather than a direct causal factor in periodontal disease [Goteiner, et al., 1986]. The risk of periodontitis in diabetic patients is increased in subjects with high levels of bacterial plaque and poor oral hygiene, and the presence of gingival inflammation over time may facilitate the onset of periodontal disease [Pradhan, 2011]. Moreover, the role of metabolic control of the disease towards the development of a possible periodontal disease in diabetic patients is not well described in the literature, as in some studies [Karjalainen et al., 1996; Tervonen, 1993] it is hypothesised that poor metabolic control may worsen gingival inflammation while, on the contrary, in other studies a significant relationship between metabolic control and periodontal status was not found [Rylander et al., 1986; De Pommererau et al., 1992]. Furthermore, most studies involve patients in adulthood [Meenawat. et al., 2013] while the periodontal disease can also occur in children and adolescents, and early diagnosis and timely treatment of periodontal disease in young patients would avoid the onset of more serious periodontal issues over time [Masamatti, 2012]; Furthermore, metabolic control may affect the periodontal status of adolescents differently than in adults because the diabetes duration is shorter.

The purpose of this study was to compare the periodontal status of diabetic adolescents with a good metabolic control and with a poor metabolic control compared to that of healthy patients of the same age.

The null hypothesis is that there are no differences in the periodontal status of adolescent patients with diabetes and in that of healthy patients.

## Materials and methods

### *Selection criteria of test patients and controls*

The present study included adolescent patients visited at the University Department of Paediatric Dentistry of the University of Pisa. A written consent (signed by parents or legal guardians) to participate in the study was obtained for each patient and all procedures were conducted in accordance with the Declaration of Helsinki.

Moreover, the present study has been approved by the Ethics Committee.

### *Inclusion criteria*

- Caucasian.
- Aged between 12 and 16 years.
- Full permanent dentition.
- Subjects physically and mentally fit.
- Type 1 diabetes.

### *Exclusion criteria*

- Presence of systemic diseases, with the exception of diabetes.
- Chronic use of drugs that could alter the status of the periodontium.
- Professional periodontal or oral hygiene sessions or treatment within 6 months prior to the screening phase
- Orthodontic treatment in progress.
- Presence of extensive decay.
- Presence of active infections, such as pharyngitis, tonsillitis, rhinitis.
- Smoking habit.

The control group consisted of patients in general good health, and specifically not affected by diabetes that were comparable to the test group for age and sex.

### *Study design*

This study included 120 patients who met the selection criteria and were equally distributed by gender.

In details, 40 patients diagnosed with diabetes mellitus type 1 with a good metabolic control (HbA1c percentage of glycated haemoglobin ≤ 7%) (20 males and 20 females; mean age: 14.1 ± 1.5 years), and 40 diabetic patients with poor metabolic control (percentage of glycated haemoglobin HbA1c> 7%) (20 males and 20 females; mean age: 14.5 ± 1.3 years) were selected consecutively.

The values of glycated haemoglobin (HbA1c) in diabetic patients were obtained from the medical records that were already available and that dated back to no more than 6 months before.

The mean duration of diabetes was similar between the two groups: 6 years and 7 months in the group of patients with well-controlled diabetes and 6 years and 4 months in the group with poor metabolic control.

Fourty patients in good general health were randomly selected as control group, and were comparable to diabetic patients by age and sex (20 males and 20 females; mean age: 14.1 ± 1.2 years).

### *Methods concerning the periodontal evaluation*

Patients were examined by the same blind examiner who was unaware of the group of the patient.

For clinical assessment, dental mirrors and a periodontal UNC probe 15 were used. During the clinical investigation the following parameters were recorded.

- Plaque Index (PI): it was assessed according to Silness and Loe [Loe et al., 1963], evaluating the presence or absence of 4 surfaces around each tooth (mesial, distal, buccal and lingual) and giving a score ranging from 0 (no plaque) to 3 (severe accumulation of plaque). Then, the mean and standard deviation of the total sites for each patient were calculated. For a better assessment of the plaque, an erythrosine plaque detector was used.
- Gingival Index (GI): to assess the conditions and qualitative changes in the gingiva. It scores the marginal and interproximal tissues separately on the basis of 0 (normal gingiva) to 3 (severe inflammation). The gingival index of Silness and Loe [Loe et al., 1963] was calculated by evaluating the presence or absence of 4 surfaces around the tooth (mesial, distal, buccal and lingual) and

giving a score ranging from 0 (no inflammation) to 3 (severe inflammation). Then, the mean and standard deviation of the total sites for each patient were calculated.

- Bleeding on probing (BOP): as reported by Ainamo and Bay [1975], it is performed through gentle probing of the orifice of the gingival crevice of 4 surfaces (mesial, distal, vestibular, lingual) of each tooth. If bleeding occurs within 10 seconds a positive finding is recorded and the number of positive sites is recorded and then expressed as a percentage of the number of sites examined.
- Probing Depth (PD): it is the distance from the gingival margin and the bottom of the groove, measured by inserting the probe parallel to the long axis of each tooth with a controlled pressure on 4 sites (mesial, distal, buccal and lingual). For each patient, we calculated the percentage of sites with value >3 mm [NieldGehrig, 2012].
- Clinical attachment level (CAL): the distance between the cementoenamel junction and the bottom of the pocket or groove, measured by inserting the probe parallel to the long axis of each tooth with a controlled pressure at 4 sites (mesial, distal, buccal and lingual). For each patient, we calculated the percentage of sites with value > 3 mm, indicating a loss of bone support [NieldGehrig, 2012].

The overall sample was divided according to the classification of Armitage [Armitage, 1999] that distinguishes eight different conditions: gingival disease, chronic periodontitis, aggressive periodontitis, periodontitis as a manifestation of systemic disease, necrotising periodontal disease, periodontal abscess, periodontitis associated with endodontic lesions, deformities and acquired or developed conditions.

### *Statystical analysis*

Clinical parameters were evaluated twice for each subject, with an interval of two weeks between the measurements to calculate the intra-operator reliability.

Cronbach's alpha was used and a value of $\alpha \geq 0.9$ was obtained for each measurement, which represents a solid cross-correlation among the data.

Statistical analysis was performed by using SPSS 22.0 (SPSS Inc, Chicago, IL, USA). Chi-square was used to compare categorical variables. Kruskal-Wallis one-way ANOVA by ranks was used to compare the quantitative variables between the three groups (GBI, PD). Post-hoc comparison between pairs of groups was assessed by Wilcoxon's rank sum test, with a downward adjustment of the $\alpha$ level to compensate for multiple comparisons. The level of significance was set at $p < 0.05$.

## Results

### *Periodontal classification (Armitage 1999)*

In PC is and WC group, the majority of patients showed a gingivitis caused by plaque, while a smaller percentage showed no periodontal disease. In addition, one subject of the PC group had a chronic localised periodontal disease (Table 1).

Comparing the two groups of patients with diabetes, no significant differences were found ($p > 0.05$) with regard to the percentage of gingivitis (p value: 0.81), chronic periodontitis (p value: 0:31) and the absence of periodontal disease (p value: 0.63). In the control group of healthy patients, however, only 13 subjects showed gingivitis associated with plaque and the other 27 patients did not show a periodontal disease. In this case, the percentage of healthy patients with gingivitis was statistically lower ($p < 0.05$) compared to the PC (p value: 0.001) and WC group (p-value: 0.004), and the percentage of patients with no periodontal disease in the control group was statistically higher ($p < 0.05$) than the PC (p-value: 0.001) and WC group (p-value: 0.004). In contrast, the CAL parameter did not show significant differences ($p > 0.05$).

No patients examined showed an aggressive periodontal disease. Table 2 summarises the periodontal status of the three groups of patients.

### *Plaque Index*

The values of PI in PC patients were significantly higher ($p < 0.0001$) compared to healthy patients. In addition, WC patients showed a significantly higher value in relation to healthy patients ($p < 0.0001$); on the contrary, no statistically significant difference was observed between the two groups of diabetic patients ($p > 0.05$).

| Periodontal disease classification | PC N: 40 | WC N:40 | Controls N: 40 | p value |
|---|---|---|---|---|
| Gingivitis | 27 (67.5%) | 26 (65%) | 13 (32.5%) | PC-WC: N.S.<br>PC-controls: p< 0.05<br>WC-controls: p<0.05 |
| Chronic periodontitis | 1 (2.5%) | 0 | 0 | PC-WC: N.S.<br>PC-controls: N.S.<br>WC-controls: N.S. |
| Absence of periodontal disease | 12 (30%) | 14 (35%) | 27 (67.5%) | PC-WC: N.S.<br>PC-controls: p< 0.05<br>WC-controls: p<0.05 |
| N.S: not significant<br>Chi-square test | | | | |

TABLE 1 Armitage periodontal classification (PC: poorly controlled; WC: well controlled; Controls: healthy subjects).

| Parameters | PC N: 40 | WC N:40 | Controls N: 40 | p value |
|---|---|---|---|---|
| PI<br>mean and SD<br>median | 2.1 ± 0.6<br>2.00 | 1.9 ± 0.8<br>2.00 | 0.8 ± 0.7<br>1.00 | PC-WC: 0.34 N.S.<br>PC-controls: p< 0.0001<br>WC-controls: p<0.0001 |
| GI<br>mean and SD<br>median | 1.9 ± 0.8<br>2.00 | 1.7 ± 0.9<br>2.00 | 0.9 ± 0.8<br>1.00 | PC-WC: 0.53 N.S.<br>PC-controls: p< 0.0001<br>WC-controls: p<0.0001 |
| GBI<br>mean and SD<br>median | 60.2 ± 23.6%<br>65.50 | 57.4 ± 22.5%<br>61.00 | 35.9 ± 18.7%<br>35.50 | PC-WC: 0.41 N.S.<br>PC-controls: p< 0.0001<br>WC-controls: p<0.0001 |
| PD > 3 mm<br>mean and SD<br>median | 26.7 ± 12.6%<br>26.00 | 23.5 ± 11.3%<br>22.50 | 8.3 ± 6.2%<br>6.50 | PC-WC: 0.3 N.S.<br>PC-controls: p< 0.0001<br>WC-controls: p<0.0001 |
| CAL > 3 mm<br>mean and SD<br>median | 1<br>0.00 | 0<br>0.00 | 0<br>0.00 | PC-WC: 0.33 N.S.<br>PC-controls: 0.33 N.S.<br>WC-controls:1.00 N.S. |
| N.S: not significant<br>Wilcoxon's rank sum test | | | | |

TAB. 2 PI (Plaque Index), GI (Gingival Index), BOP (Bleeding on probing), PD (Probing Depth), CAL (Clinical Attachment Level) in the three groups (PC: poor controlled diabetics; WC: well controlled diabetics; Controls: healthy subjects). Mean, Standard Deviation (SD) and Median.

### *Gingival Index*

GI IN PC patients was significantly higher (p <0.0001) compared to healthy patients. In a similar manner, WC subjects had a GI value statistically higher compared to healthy patients of the control group (p <0.0001). Instead, by comparing GI values of the two groups of patients with diabetes with different metabolic control, no significant differences were found (p> 0.05).

### *Bleeding on probing*

Bleeding on probing (BOP) was present in a higher number of periodontal sites in PC and WC groups, while in the control group it was present in a lower percentage.

By comparing each group of diabetic patients with the group of healthy patients, a statistically significant difference was found (p <0.0001).

On the contrary, by comparing the two groups of diabetic patients, no statistically significant difference was found (p> 0.0001).

### *Probing Depth*

The percentage of sites with PD > 3 mm was significantly higher (p <0.0001) in the PC and WC groups compared to controls. In contrast, comparing the PC and WC groups, the difference was not significant (p> 0.05).

### *Clinical Attachment Level*

In the group of PC patients, a pathological site with a CAL value > 3 mm for each subject was measured. Both in the WC group and in controls no pathological CAL was found, since all the measurements did not exceed 3 mm. Thus, the statistical analysis showed no significant difference between groups (p> 0.05).

## Discussion

Diabetes mellitus type 1 causes in children and adolescents severe alterations in the oral cavity and it leads to a reduction in physiological defenses against inflammation, which manifests itself as gingival redness, oedema and bleeding on probing [Masamatti, 2012].

Our study showed that diabetic adolescents have a higher degree of gingival inflammation and plaque buildup compared to healthy subjects of similar age, despite the similar oral hygiene and dietary habits.

Gingival inflammation is closely related to the supra- and subgingival accumulation of plaque and high levels of dental plaque cause gingival inflammation, oedema and gingival bleeding [Giuca MR. et al., 2014].

The mechanisms by which diabetes can lead to an increase of gingival inflammation are numerous and include: alterations of blood vessels that facilitate gingival bleeding, increased levels of calcium in the saliva that promote the formation of tartar [Phlips, 2012 ], the formation of AGE glycosylated proteins that cause an increase in the thickness of the basement membrane and overexpression of growth factors and pro-inflammatory cytokines such as TNFα (Tumor Necrosis Factor alpha) and IL-1β (interleukin 1 beta) that can stimulate gingival inflammation [Grossi, 1998], the presence of a greater number of Gram-negative bacteria which release bacterial products such as endotoxin and lipopolysaccharide that amplify inflammatory responses [Orbak, 2008]. Regarding the relationship between metabolic control and gingival inflammation, some studies showed a correlation between poor control and periodontal status [Tervonen, 1993; Meenawat et al., 2013].

Furthermore, Orbak et al. [2008] suggested that periodontal treatment in diabetic patients is able to reduce the glycosylated haemoglobin, due to the elimination or reduction by the therapy of Gram-negative bacteria that - through the production of toxins - induce insulin resistance, thus worsening the metabolic control [Orbak, 2008].

It has been found that diabetes affects the periodontal status resulting in a greater periodontal inflammation and deeper pockets [Aren, 2003]. However, in this study, no significant differences between adolescent patients with well-controlled and uncontrolled diabetes were found,

perhaps due to the age of the patients and the short duration of diabetes. The presence of deposits of bacterial plaque, gingival inflammation and bleeding on probing are the main predictive factors that can lead to the onset of periodontal disease with irreversible loss of periodontal support. However, in this study, no periodontal lesions (except for one diabetic patient) were found.

The absence of pathological periodontal pockets in adolescent patients leads to hypothesise that irreversible periodontal lesions, characterised by CAL> 3 mm, require a long time to be to established and that the finding of a higher probing depth is due to gingival hyperplasia rather than the actual deepening of the pocket itself. This does not mean that in diabetic adolescents this issue should be overlooked, because if not treated promptly could lead to more serious periodontal lesions over time.

Therefore, young patients with diabetes should be educated on proper oral hygiene care with the use of toothbrush, dental floss, interdental brushes, gels and mouthwashes to counteract the accumulation of bacterial biofilm. In addition, patients should be monitored regularly in order to assess the periodontal status, and for scheduled sessions of professional oral hygiene.

## Conclusion

Adolescents with type 1 diabetes show a higher level of deposits of bacterial plaque, gingival inflammation, bleeding on probing and probing depth compared to healthy subjects. However, no significant changes were found in the periodontal status according to different metabolic control.

Overall, adolescent patients showed no signs of destruction of periodontal clinical attachment, therefore it would seem that pathological pockets requires more time to develop before they are detected in older adults.

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