Periodontal parameters and oral hygiene in diabetic and nondiabetic adolescents in Zanjan

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Abstract
Background: Periodontal disease and diabetes mellitus are 2 most common encountered chronic diseases. The occurrence, appearance, and severity of the periodontium tissue conditions vary during adolescence. Also, there is controversy about the relationship between diabetes mellitus and increased periodontal disease breakdown during puberty. This study aimed to assess the periodontal parameters and oral hygiene in diabetic and nondiabetic adolescents in city of Zanjan.

Methods: In this case and controls study, 140 diabetic (case) and 140 nondiabetic (control) adolescents were compared. The participants were matched by age, sex, and socioeconomic status using the group matching method. Clinical attachment loss, periodontal pocket depth, gingival index, periodontal index, and bleeding on probing were measured for the 6 Ramfjord index teeth. Data were analysed using descriptive statistics, chi-square test, t test, and one-way ANOVA using SPSS version 18.

Results: The mean age of the diabetic and nondiabetic group was 16.7±1.6 and 17.1±0.30 years, respectively. Duration of diabetes was 2.15±0.86 years. Mean clinical attachment loss, periodontal pocket depth, gingival index, and bleeding on probing were measured for the 6 Ramfjord index teeth. Data were analysed using descriptive statistics, chi-square test, t test, and one-way ANOVA using SPSS version 18.

Conclusion: Both diabetic and nondiabetic adolescents had equally poor oral hygiene. Gingivitis and periodontitis indices were significantly poorer in diabetic patients.

Keywords: Diabetes Mellitus, Oral hygiene, Periodontal diseases, Health

Conflicts of Interest: None declared

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Introduction
Diabetes mellitus (DM) is the most common metabolic disorder and is among the most important public health dilemmas worldwide (1). There is a steady rise of DM in childhood, and the frequency of children diagnosed with DM approximately doubles every decade. This disease poses some complications, especially on oral health (2). DM causes several systemic disorders (retinopathy, neu-
Periodontal oral hygiene diabetic adolescents

ropathy, nephropathy, cardiovascular diseases, and non-traumatic lower limb amputations) and orodontal complications (dental abscesses, xerostomia, periodontal disease, and tooth loss) (3, 4). The number of DM patients has been increasing in many developing countries, especially among the younger people, which has a negative effect on their quality of life and increases hospitalization period with subsequent raising burden on health care costs (5). In contrast to healthy individuals, periodontal disorders occur at younger ages. Moreover, gingival involvement is usually manifested at earlier ages in diabetic teenagers (6).

Periodontal disease (PD) is the sixth main complaint of diabetic patients. Presence of chronic diseases such as PD can negatively affect DM management (7). Evidence shows a mutual relationship between metabolic control of diabetes by eliminating bacterial infection in PD and increased severity of periodontitis due to inadequate control of DM (7, 8). Thus, assessment of oral hygiene (OH) status and periodontal health of diabetic patients is particularly important. Moreover, adolescents account for a large number of diabetic patients (9). While experiencing rapid biological and hormonal changes, adolescents are developing independence from parents. It is generally believed that DM is associated with development of psychological problems in adolescence (10).

During the puberty phase, there is an increase in growth hormone (GH) production, with subsequent raise in glucose release due to enhanced gluconeogenesis and glycogenolysis processes (11). As a result of a psychological crisis following hormonal changes, this group of patients need more precise supervision and hygiene screening (12).

On the other hand, inflammation in children is different from that in adults because their immunological processes are deficient as the result of incomplete development of immune cells. Therefore, conversion of T to B lymphocytes is not performed adequately. To our knowledge, B lymphocytes produce the main portion of destructive cytokines in inflammatory conditions (13). As a result, destructive processes during inflammation, which are proportionate to the amount of dental plaque, do not progress as those in adults (14, 15). Moreover, due to the small number of plasma cells, chronic gingivitis in children is similar to the initial stage of disease in adults, which is nondestructive and nonprogressive (13).

However, although DM does not directly cause gingivitis and PD in children, there is controversy in this regard in the literature. Evidence shows that in diabetic patients, inflammatory response of the periodontal tissue changes to a pro-inflammatory condition (dental plaque). Also, studies have shown that formation of dental calculus in diabetics is susceptible to dental calculus formation than nondiabetics (1, 12, 14). However, Lopez et al. showed that formation of dental calculus in diabetics is higher than that in nondiabetics (1, 12, 14). However, Lopez et al. showed that formation of dental calculus in diabetics is higher than that in nondiabetics (1, 12, 14). However, Lopez et al. showed that formation of dental calculus in diabetics is higher than that in nondiabetics (1, 12, 14).

In this case and controls study, 140 diabetic adolescents were randomly selected among those presenting to the Metabolic Disease Research Center in Zanjan, Iran, and constituted the patient group. The control group comprised of 140 nondiabetic adolescents randomly selected among those presenting to dental school.

Time was chosen as a randomization component. Any patient that was present in odd days of the week and met the inclusion criteria was selected as a case group until their number reached 140. Group matching method was used to adjust for age, sex, and socioeconomic effects in case and control groups. Those friend or family members that accompanied the cases were considered as controls if they met the inclusion criteria. Those individuals who completed medical and dental records and aged between 10 to 19 years and whose parents agreed to take part in the research were entered (29). The exclusion criteria were positive history of any systemic diseases such as epilepsy, Sjogren disease, dry mouth, malignancy, and immune system disorders. Moreover, patients under orthodontic or periodontal treatment, recent antibiotic therapy, those who experienced chemotherapy and radiotherapy or taking drugs with potential effect on periodontal tissue (phenytoin, cy-
explained to all participants prior to the study. Parents of
ences, Iran (NO: 920217). The aim and procedures were
ethics committee of Zanjan University of Medical Sci-
immol/mol) (14, 30).
(7.0 mmol/L), or 2-hour glucose (OGTT) ≥ 200 mg/dL
symptoms of hyperglycemia (polyuria, polydipsia, and un-
were also excluded (1, 14, 20).
clinical examination, reviewing patient files, and
found in the questionnaire (31, 32). The second part included
The gingival index (GI) was measured according to the
(11.1 mmol/L), or 2-hour glucose (OGTT) ≥ 200 mg/dL
were also retrieved from patients’ files and recorded in the ques-
dentifed according to the O’Leary’s index (35) around the 6
PPD, and GI in diabetic adolescents were significantly
in nondiabetics (p<0.001). On the other hand, CAL was significantly higher in diabetic ado-
in control group (p<0.001). However, the mean PI of the 2 groups was not significantly different
The frequency of low, moderate, and severe GI, PI, CAL,
heights of the 2 groups (p>0.05) (Table 2).
However, significant differences were noted in CAL of diabetics based on dental flossing (p=0.014), frequency of
tooth brushing (p=0.051), and blood glucose control (BGC) (p=0.047). However, in nondiabetics, the CAL was not signi-
ificantly different based on the above-mentioned vari-
bles.
The amount of PI was not significantly different in dia-
abetes in terms of these variables, but it was significantly
different in nondiabetics based on exercising (p=0.043).
Significant differences were also noted in GI based on
dental flossing (p=0.003), using mouthwash (p=0.025), and
BGC (p=0.052). However, in nondiabetics, the GI was not

**Table 1.** Comparing PPD, BOP, GI, and CAL between diabetic and nondiabetic adolescents

<table>
<thead>
<tr>
<th>Periodontal parameters</th>
<th>Diabetic adolescents</th>
<th>Nondiabetic adolescents</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PPD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity of gingival inflammation (BOP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (0-0.24)</td>
<td>0</td>
<td>48 (35.6)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Moderate (0.25-0.74)</td>
<td>3(2.3)</td>
<td>69 (51.1)</td>
<td></td>
</tr>
<tr>
<td>Severe (≥0.75)</td>
<td>129 (97.7)</td>
<td>18 (13.3)</td>
<td></td>
</tr>
<tr>
<td><strong>GI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy (0-0.9)</td>
<td>42(30.2)</td>
<td>105 (77.8)</td>
<td>&lt;0.001*</td>
</tr>
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<td>Low (1-2)</td>
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<tr>
<td>Moderate (2.1-4)</td>
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<td></td>
</tr>
<tr>
<td>Severe (≥4.1)</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>CAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy (0-0.9)</td>
<td>2(1.5)</td>
<td>2 (1.4)</td>
<td></td>
</tr>
<tr>
<td>Low (1-2)</td>
<td>38(28.1)</td>
<td>124 (89.2)</td>
<td>&lt;0.001*</td>
</tr>
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<td></td>
</tr>
<tr>
<td><strong>PI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>1 (0.7)</td>
<td>3 (2.14)</td>
<td>0.183</td>
</tr>
<tr>
<td>Moderate</td>
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<td>10 (7.14)</td>
<td></td>
</tr>
<tr>
<td>Weak</td>
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<td>127(90.71)</td>
<td></td>
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</table>

*: mean (SD), S: Frequency (%), &: Independent t test , ϵ:Chi-square test

**Results**

In this study, a total of 280 adolescents, including 140
diabetics (69 males; 71 females) and 140 nondiabetics (70
males; 70 females) were evaluated. Of the participants, 139
(49.6%) were male and 141 (50.4%) were females. Dura-
tion of diabetes was also 2.15±0.86 years. The mean age of
the diabetic and nondiabetic group was 16.7±1.06 and
17.1±1.30 years, respectively.

The severity of gingival inflammation (BOP), the mean
PPD, and GI in diabetic adolescents were significantly
higher than in nondiabetic adolescents (p<0.001). On the
other hand, CAL was significantly higher in diabetic ado-
lecents than in control group (p<0.001). However, the
mean PI of the 2 groups was not significantly different (p=0.182) (Table 1).

The frequency of low, moderate, and severe GI, PI, CAL,
and BOP was compared between the 2 groups controlling
the following variables: dental flossing, tooth brushing,
blood glucose control, use of mouthwash, exercise, and fre-
quency of daily tooth brushing. The BOP was not signifi-
cantly different based on the above-mentioned variables in
the 2 groups (p=0.05) (Table 2).

Findings were analysed by chi-square test, descriptive sta-
tistics (central dispersion indices and frequency distribu-
tion), and independent t test via SPSS software (version 18,
SPSS Inc., Chicago, IL, USA). P value < 0.05 was consid-
ered significant.

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<td>1 (0.7)</td>
<td></td>
</tr>
<tr>
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<td>1 (0.7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>CAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy (0-0.9)</td>
<td>2(1.5)</td>
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<td>2 (1.5)</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
Periodontal oral hygiene diabetic adolescents

Table 2. Comparing BOP between diabetic and nondiabetic adolescents controlling oral hygiene, blood glucose, and exercising

<table>
<thead>
<tr>
<th>Oral hygiene</th>
<th>Sample group</th>
<th>BOP in diabetic adolescents</th>
<th>BOP in nondiabetic adolescents</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Severity</td>
<td>Low</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Dental flossing</td>
<td>Yes</td>
<td>1 (0.8)</td>
<td>34 (25.8)</td>
<td>25 (18.5)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2 (1.5)</td>
<td>95 (67.2)</td>
<td>23 (17)</td>
</tr>
<tr>
<td>Blood glucose control</td>
<td>Daily</td>
<td>0</td>
<td>6 (4.6)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Weekly</td>
<td>0</td>
<td>13 (9.9)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Monthly</td>
<td>2 (1.5)</td>
<td>53 (40.5)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Whenever I</td>
<td>1 (0.8)</td>
<td>56 (42.7)</td>
<td>-</td>
</tr>
<tr>
<td>Can</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using mouthwash</td>
<td>Yes</td>
<td>1 (0.8)</td>
<td>19 (14.4)</td>
<td>11 (8.1)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2 (1.5)</td>
<td>110 (83.3)</td>
<td>37 (27.4)</td>
</tr>
<tr>
<td>Exercising</td>
<td>Yes</td>
<td>0</td>
<td>50 (38.7)</td>
<td>14 (10.4)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>3 (2.3)</td>
<td>99 (75)</td>
<td>34 (25.2)</td>
</tr>
<tr>
<td>Frequency of daily</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tooth brushing</td>
<td>Once Daily</td>
<td>2 (1.5)</td>
<td>63 (48.1)</td>
<td>18 (13.3)</td>
</tr>
<tr>
<td></td>
<td>&gt;Once Daily</td>
<td>1 (0.8)</td>
<td>17 (13)</td>
<td>22 (16.3)</td>
</tr>
</tbody>
</table>

#: Kendalls tau test, &: Chi_square test

Discussion

This study was unique as it was designed to compare the different severity and type of periodontal indexes, oral hygiene approaches, and physical activity of the adolescent population (N=280).

Some of the limitations to be mentioned are extensive exclusion criteria, lack of patient’s cooperation, incompleteness of information in records, and homogenization of sex and social levels. In this study, diabetics and nondiabetics were significantly different in terms of severity of periodontal tissue inflammation determined by BOP. Similarly, Preshaw et al reported that diabetics had higher BOP than the nondiabetics (31). Moreover, Meenawat A et al reported that this index was significantly higher in type I diabetic patients (32).

In this study, similar to research of Patinomarin et al, CAL was significantly different in diabetic and nondiabetic adolescents (36). Also, the present study was in agreement with that of Grossi et al which showed that CAL had no significant correlation with the frequency of dental visits but had a significant correlation with blood glucose control.

The present study, in line with that of Patinomarin et al (36) and Preshaw et al (31), showed that the mean PPD in diabetic adolescents was significantly higher than that in healthy individuals. Thus, it seems that diabetic adolescents are at higher risk of PD progression compared to nondiabetics. There is some evidence supporting that diabetes has an effect on controlling glucose level (19, 37).

In a similar study, Mazhari et al reported the frequency of moderate to severe gingival inflammation in diabetic adolescents (12.9%), which was significantly higher than that in healthy individuals (0.7%, moderate inflammation). Moreover, in agreement with the results of Mazhari et al, GI was not significantly correlated with BGC and dental visits (38). However, the value of this index in the study by Apoorva et al was much higher than that in this study (39). This difference in the prevalence of gingivitis can be due to higher severity of PD in patients who have DM for a long time compared to nondiabetics (37). However, in contrast to this study, Siudikiene et al and Apoorva et al stated that BGC was effective in decreasing the severity of PD (16, 39). Controversy in the results of different studies may be due to difference in sample size and periodontal indices studied.

The findings of the present study, in agreement with those of Patinomarin et al (36) and Mazhari et al (38), showed that PI was not significantly different between diabetics and nondiabetics, while Siudikiene et al (16) demonstrated that PI in diabetics was significantly higher than that in nondiabetics. Santos showed that systemic antibiotic therapy in diabetic patients has relatively insignificant benefits in terms of decrease in mean PD and mean percentage of BOP (40).

In nondiabetic patients of this study, none of the periodontal parameters (GI, BOP, PI or CAL) had a significant correlation with OH, but CAL and GI in diabetics were significantly correlated with OH. The controversy in the results of this study can be due to very poor OH of adolescents in both groups. Irrespective of psychological crisis secondary to hormonal changes, the poor OH can be due to cultural deprivation and no access to hygienic information which may result in infrequent dental visits and not paying attention to OH (19, 36). Moreover, lack of strong motivation for OH control is another possible reason for not seeking dental care by adolescents (41).

However, the role of DM in development of PD has not yet been well established (42). Type 2 DM and poor control of glucose level have negative effects on periodontal health status (43). There are some hypotheses stating that DM increases the susceptibility to juvenile periodontitis via different mechanisms, including nonenzymatic processes producing advanced glycation end products that negatively affect the activity of proinflammatory cytokines, including IL-1 and tumor necrosis factor, and increases the expression of toll-like receptors (42, 44).

Frequent infections due to immunological changes in diabetics and impaired function of polymorphonuclears, impaired blood flow in capillaries, and changed response of proinflammatory proteins in the gingival tissue are among other possible mechanisms. Change in the subgingival microbial flora and emergence of anaerobic Gram-negative bacteria have also been reported in diabetic adolescents (42). The severity of DM and PD is also indirectly corre-
lated with the factors affecting general health such as nutrition, quality of life, and OH (45).

Since this study has differences with previous studies in terms of number and age of patients, periodontal indices measured, study variables and ethnicity and race of patients, further studies with a larger sample size are required to assess some other indices to increase the generalizability of results to the entire population of diabetic adolescents (42).

Conclusion

All periodontal parameters (except PI) in diabetic adolescents were significantly greater than those in nondiabetics. Both diabetic and nondiabetic adolescents had equally poor oral hygiene.

In dental clinics with special focused care for patients with severe periodontitis, screening programs for diabetes should be available to identify new cases of diabetes early. This will prevent some severe complications and can benefit periodontitis therapy. Therefore, targeted oral health program should be developed for this population to promote public health.

Acknowledgments

The authors would like to thank the contribution of Metabolic Disease Research Center of Zanjan University of Medical Sciences, and all of patients who participated in this study.

Conflict of Interests

The authors declare that they have no competing interests.

References

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