Evaluation of caries risk factors and effects of a fluoride-releasing adhesive material in children with insulin-dependent diabetes mellitus (IDDM): initial first-year results

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The aims of this study were to evaluate the prevalence and risk factors of dental caries, and to determine whether there is any relationship between a fluoride-releasing adhesive material and the development of dental caries in the first year in children with insulin-dependent diabetics (IDDM). The average age of the subjects was 4–15 years, and they had been suffering from IDDM for at least 2 years. The DMF/df(t) indices of 70 patients were calculated and total HbA_1 (%) (glucose levels of blood) values were recorded from the medical records after clinical examination. The mean DMF/df(t) values of poorly controlled subjects (HbA_1 values over 13%) were significantly higher than those of moderately (HbA_1, 10.0–12.9%) and well-controlled (HbA_1 values, <10%) subjects. The levels of salivary mutans streptococci (MS) and lactobacilli (LB) and the pH of paraffin-stimulated whole saliva were measured in diabetic patients. Salivary MS and LB scores of the poorly controlled subjects were significantly higher (2.5 ± 0.7 and 2.1 ± 1.0) than those of the moderately (1.6 ± 0.9 and 1.1 ± 0.8) and well-controlled (1.2 ± 1.0 and 0.8 ± 0.8) subjects. The mean pH values among all subjects were not statistically significant. All dental caries were restored with a fluoride-releasing adhesive material. At the end of the first year, no new caries or lost restorations were observed in these patients. Moreover, the rate of MS in the poorly and moderately controlled subjects was considerably reduced. However, no significant statistical reduction of MS was determined in the well-controlled subjects. The level of lactobacilli in the poorly controlled, moderately controlled, and well-controlled subjects was reduced. □ *Dental caries; diabetes mellitus; fluoride-releasing; glass ionomer; lactobacilli; mutans streptococci*

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Diabetes mellitus is a lipid and carbohydrate metabolism disease that emerges as a result of either a deficiency in insulin production or an impaired utilization of insulin. It is not generally agreed that diabetics are at greater risk of developing caries than are healthy individuals (1). Diet and saliva are the most significant factors for caries development. In diabetic patients, the dietary recommendations concerning carbohydrates stress the lack of sucrose in the diet list. Therefore one could expect the dietary habits of diabetics not to favor the multiplying of cariogenic bacteria and the subsequent development of carious lesions. Besides, the relationship between dental caries and insulin-dependent diabetes mellitus (IDDM) is not clear. Studies on the occurrence of caries in diabetic patients have been controversial, most showing a higher (2), similar (3), or lower (1, 4, 5) prevalence of caries among diabetics than among controls.

It is known that mutans streptococci (MS) colonization in both the primary and the permanent dentition can result in a high risk of caries, while it has been shown that fluoride is effective in reducing MS colonization and preventing caries (6). Many investigators have reported substantial decreases in salivary MS levels after placement of a fluoride-releasing adhesive material (7). The importance of the patient's age at the onset of diabetes with regard to later development of caries has been stressed in some reports (1, 8, 9).

The aim of this study was to evaluate the prevalence and risk factors of dental caries in children with IDDM. A secondary aim was to determine whether there is any relationship between fluoride-releasing adhesive material and the development of dental caries in the first year of follow-up.

Materials and methods

The study population comprised 70 patients with IDDM (41 F, 29 M; mean age 9 years; range 4–15 years), and those with diabetes of at least 2 years' duration were included in the study at the Diabetic Clinic of the University of Dicle. The subjects received several injections of insulin daily, and visited the university hospital approximately every 3 months for follow-up and adjustment of diabetes treatment. They were otherwise healthy and not taking any other medications regularly.

The presence of caries was clinically diagnosed by three pedodontists on all teeth by visual examination and

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Table 1. The comparison of initial values (mean ± standard deviation) for poorly, moderately, and well-controlled children diagnosed with insulin-dependent diabetes mellitus (IDDM)

	Well-controlled subjects	Moderately controlled subjects	Poorly controlled subjects	
Number	15	30	25	
Age	5.6 ± 1.2	6 ± 1.2	11.2 ± 2.3	$P < 0.001$
Female/male	9/6	19/11	13/12	
Mean HbA_1% (6 months)	8.1 ± 0.9	11.2 ± 0.7	15.7 ± 1.5	
DMF(T)/df(t)	2.2 ± 1.7	4.1 ± 1.9	7.1 ± 2.4	$P < 0.001$
Salivary PH	6.7 ± 0.5	6.8 ± 0.7	7.3 ± 0.8	NS
Salivary MS	1.2 ± 1.0	1.6 ± 0.9	2.5 ± 0.7	$P < 0.001$
Salivary LB	0.8 ± 0.8	1.1 ± 0.8	2.1 ± 1.0	$P < 0.001$

NS = non-significant.

probing, and following the WHO guidelines (10). No radiographs were taken. DMF(T) and/or df(t) indices were calculated.

Paraffin-stimulated whole saliva samples were collected for 5 min at least half an hour after the previous meal. Immediately after collection, the pH of the saliva was measured electrometrically (Orion Research 210 digital pH meter). A CRT bacteria test (two in one system, Vivadent Ets., Schaan/Liechtenstein), which is a dip-slide method, was used to determine the salivary levels of MS and LB. In this examination, one surface of a specifically designed test tube was used to spread the saliva for the MS score and the other surface for the LB score. Bacteria levels were expressed as colony-forming units (cfu) per milliliter of saliva in accordance with the manufacturer's recommendations. In this procedure, both bacteria were scored from 0 to 3 (0 and $1 < 10^5$, 2 and $3 \geq 10^5$).

Total HbA_1(%) values were recorded from medical records after clinical examination. Mean HbA_1 values over the previous 6 months (mean of 2–4 HbA_1 values, $n = 70$) were calculated. Values HbA_1 <10% indicated good control of diabetes, 10.0–12.9% moderate control, and >13% indicated poor control.

All caries cavities were restored using resin-modified glass-ionomer material, and fissure sealant was applied on surfaces liable to caries by the same material (Vitremer 3M Dental Products, St. Paul, Minn., USA).

At the end of the first year, the DMF/df(t) values and salivary MS/LB counts of 61 patients were calculated. Nine patients dropped out from the treatment without explanation.

Statistical analyses

Analysis of variance (ANOVA) was used to determine the significance of differences between groups. Tukey's HSD was used for comparison of the means. A paired *t* test was used to determine the difference between the initial and first year follow-up data.

Results

Subjects with poorly controlled diabetes had significantly more caries lesions than did well or moderately controlled cases. None of the 70 children examined in this study had previously filled surfaces. The mean DMF(T) and/or df(t) values of the poorly, moderately, and well-controlled subjects were 7.1 ± 2.4, 4.1 ± 1.9, and 2.2 ± 1.7, respectively ($P < 0.001$) (Table 1).

At the end of the first year, no statistically significant differences were found in the DMF/df(T) values of 61 patients compared with initial values ($P > 0.05$) (Table 2). These results were related to the restorations performed, i.e. to increasing the filling (F) component (Table 3). In addition, in this 1-year evaluation, no new caries or lost restorations were observed in these patients.

Moreover, the rate of MS in the poorly controlled ($P < 0.001$) and moderately controlled ($P < 0.05$) children was considerably reduced at the end of the first year. No significant statistical reduction of MS in well-controlled children was determined ($P > 0.05$). The rate of lactobacilli in the poorly controlled ($P < 0.001$), moderately controlled

Table 2. The initial and first-year results (mean ± standard deviation) in DMF(T), mutans streptococci, and lactobacilli in poorly, moderately, and well-controlled children diagnosed with insulin-dependent diabetes mellitus (IDDM)

	Well-controlled subjects ($n = 15$)		Moderately controlled subjects ($n = 26$)		Poorly controlled subjects ($n = 20$)	
	Initial	First year	Initial	First year	Initial	First year
DMF(T)/df(t)	2.5 ± 1.3	2.2 ± 1.7 NS	4.0 ± 1.9	3.9 ± 1.2 NS	7.5 ± 1.9	7.3 ± 1.7 NS
Salivary MS	1.2 ± 1.0	0.9 ± 0.5 NS	1.6 ± 0.9	1.2 ± 0.6 $P < 0.05$	2.5 ± 0.7	1.3 ± 0.6 $P < 0.05$
Salivary LB	0.8 ± 0.8	0.6 ± 0.7 $P < 0.05$	1.1 ± 0.8	0.6 ± 0.6 $P < 0.001$	2.1 ± 1.0	1.2 ± 1.0 $P < 0.001$

NS = non-significant.

Table 3. Dental restorations in poorly, moderately, and well-controlled children diagnosed with insulin-dependent diabetes mellitus (IDDM)

	Well-controlled subjects ($n = 15$)	Moderately controlled subjects ($n = 26$)	Poorly controlled subjects ($n = 20$)
Restoration	21	63	89
Fissure sealant	14	38	42

($P < 0.001$), and well-controlled ($P < 0.05$) subjects was reduced (Table 2).

Discussion

In the present study, the relationship between level of metabolic balance and development of caries was studied in children with IDDM. We observed higher mean DMF/df(t) values in poorly controlled subjects than in moderately or well-controlled subjects, which is in contrast to many other studies where no differences have been found in caries prevalence between well-controlled and poorly controlled diabetics (1, 3, 11). However, similar results have been found to those of our study, e.g. Galea et al. (8) found that diabetics with caries are mostly poorly controlled. In addition, it has been shown that the presence or absence of intact dentition is related to metabolic balance (12).

Hyposalivation has been reported to be associated with diabetes (13). Glucose level in the gingival fluid and saliva is known to correlate with blood glucose (14), and it has been reported that levels of blood glucose (HbA1) are increased in diabetics (11, 12). In our study, HbA1 was measured and, particularly in diabetic children with poorly controlled disease, the caries incidence was higher than in well-controlled children. High HbA1 values may therefore be related to an elevated risk for caries in poorly controlled diabetic subjects.

In some investigations, no relationship was found between caries and duration of diabetes (15, 16). More caries has been found in diabetics who have suffered from the condition for less than 5 years than in those who have diabetes for more than 5 years (8). Onset of diabetes before age of 6–7 years results in a lesser risk of caries than onset after that age (9). In another study it was found that in long-term diabetic subjects and in those with onset of diabetes before the age of 7 years, poor control of diabetes increases the risk for caries development and loss of intact dentition (12).

Twetman et al. (17) found that caries incidence is significantly higher during the first year of diabetes than during the second. Mattson & Koch (9) were able to show that if all permanent teeth erupt after onset of the disease dental health is significantly better among diabetics in all studied age groups.

It has been shown that there is a positive correlation between MS, LB, and caries prevalence (18–20). MS, in particular, is of major etiologic significance in human dental caries. The capacity of this microorganism to initiate dental caries depends on its ability to release organic acids and to produce adhesive extracellular polysaccharides. Lactobacilli are related to the development of caries lesions, especially after the initiation of caries. The growth of lactobacilli is favored by a frequent intake of fermentable carbohydrates, and salivary lactobacilli counts are useful in predicting future caries activity. However, it has been found that the dietary treatment of young insulin-dependent diabetics gives rise to a reduced number of lactobacilli in saliva but does not affect the mutans streptococci (21). Twetman et al. (22) emphasized that among the common risk factors associated with caries, consistently poor oral hygiene, previous caries experience, and high levels of salivary lactobacilli all showed a strong relation to disease. These observations were confirmed in the present study, where it was found that the rate of MS and lactobacilli in poorly controlled children was considerably higher compared with moderately or well-controlled children.

Although dietary intake of refined carbohydrates by diabetics is lower than by non-diabetic individuals, it should be noted that in diabetics a high number of meals per day could promote caries development. These facts together with the leakage of blood glucose into the oral cavity are the likely explanations for the presence of cariogenic bacteria, and for the subsequent development of dental caries among diabetics (1).

Poor control may be a result of negligence in relation to diabetes care and treatment regimens, and such subjects may be careless about their dental health and dental care. However, in our study, the subjects had not received regular dental treatment.

In conclusion, poor control of diabetes was found to increase caries incidence in children with IDDM compared to those in whom diabetes is well controlled. To that end, we restored the teeth suitable for restoration with a fluoride-releasing adhesive material.

It has been shown that the presence of fluoride in restorative material during a caries attack is effective in the prevention or reduction of caries. In our study, no statistically significant different alterations were found in DMF/df(T) values at the end of the first year. In this 1-year evaluation, no new caries or lost restorations were observed in these patients.

It has been known that glass-ionomer restorative materials have the ability to bond to mineralized tooth structure and the release of fluoride. Moreover, the release of fluoride is initially high and attains a low, fairly constant level after 2 to 3 months. Glass-ionomer materials may also be recharged with fluoride (23).

The first-year results of our study show that the use of glass-ionomer material as a fluoride-releasing adhesive material is effective in reducing caries, especially in poorly controlled children in comparison with well-controlled children.

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