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Influence of Diet on Dental Caries in Diabetics

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A B S T R A C T

Two groups of population consisting of 84 patients suffering from diabetes (60 type I, 24 type II) and 69 nondiabetics of the same age have been examined on: oral hygiene index (OHI), frequency of daily tooth brushing, dietary habits and incidence of dental caries by registration of the decayed, missed and filled dental surfaces (DMFS-index). OHI in type I and type II diabetes was found to bee slightly worse than in nondiabetics, but not significantly ($p > 0.05$). In the number of daily tooth brushing there is not significant difference between diabetics and nondiabetics. All diabetics have considerably lower daily intake of total as well as simple carbohydrates than nondiabetics. The diabetics have a significantly higher daily intake of dietary fibers, calcium and phosphorus as well as the number of meals with simple carbohydrates and also DMFS-index than the nondiabetics. A significantly higher incidence ($p < 0.01$) of caries location was found on the buccal and labial cervical areas among patients suffering from diabetes. Explanation for this could be more frequent daily intake of lowmolecular carbohydrates with an improper calcium phosphorus ratio.

Introduction

The influence of nutrition on human health has been proved in many multifactorial diseases such as dental caries and diabetes mellitus. These diseases may be particularly severe if inadequate nutrition is combined with poverty, social insecurity and ignorance. Dietary habits affect the teeth and their inclination toward caries in the three main events: the preeruptive development of the tooth crown, the maturation after eruption and the maintenance of the teeth in the full function[3]. Particularly during the period of full teeth function nutrition plays a very important exogenous role in the incidence of caries. Up to now the carbohy-

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drates were considered to be the most important macronutrient in the etiology of caries, especially lowmolecular mono and disaccharides. A substitution of saccharose with glucose, fructose or maltose in human diet has not resulted in a considerable caries decrement and lactose that was regarded as less cariogenic then the former also significantly correlates with the incidence of caries[2]. Starch is the most important source of carbohydrates in human nutrition. It is a complex glucose polymer which, in certain conditions of digestion in the oral cavity, can be split into smaller chains, maltose and finally glucose indicating a definite cariogenicity of this widest spread polysaccharide in human diet[3,4]. A combined reduction of lowmolecular carbohydrates and proteins in diet has been connected with a decrease in caries incidence among diabetics[5–8]. Poorly controlled diabetics show a much higher incidence of caries possibly caused by diminished salivary flow and a higher local glucose content[9,10]. The purpose of this study was to find out and to analyze what influence nutrition has on the prevalence of caries among diabetics compared with nondiabetics.

Materials and Methods

The investigation was conducted from May 1995 to April 1997 at the Department of Dental Pathology and at the Clinic for Diabetes of the Zagreb University. Sixty patients suffering from type I diabetes, 24 with type II diabetes and 69 nondiabetics, randomly chosen, entered the study. The mean age and the social economic status of urban population in all 3 groups were alike (type I mean age 28.7 ± 3.4; type II mean age 32.6 ± 4.1; nondiabetics mean age 30.3 ± 4.3; overall mean 30.4 ± 6.3; overall range 20–45 years). The duration of diabetes was 3.4–15.2 years, mean 8.2 ± 1.3 years. Of the all 84 diabetics 55 had HbA1 values < 10% and 29 > 10% by two last sampling.

The examinees were questioned about their dietary habits during spring and autumn because of similar nutritional conditions and greater variety in diet. The »24 hour recall« method was performed examining dietary habits. The interviews were based on the memory of examinees using plastic food models for easier understanding and recollecting of the foods taken the day before. The average daily quantities of macro and micronutrients brought into the organism were stated. In analyzing a carbohydrate intake, particular attention was paid to their complexity and presence in each meal during the day. The meals containing »hidden« simple carbohydrates such as fruit (fructose, glucose) and milk (lactose) were registered as meals with simple carbohydrates. Tables of Chance and Windowson[11] made the evaluation of food ingredients. Oral hygiene was determined mined by daily frequency of tooth brushing and using the Green-Vermillion method[12] with the help of »Blendax Antiplaque« (Pliva, Zagreb), and dental plaque coloring solution.

The registration of dental caries was made by the Marthaler method[13] including complete dental statuses of all tooth surfaces – DMFS index (D = decayed, M = missing, F = filled, S = surface). In order to obtain a more precise insight into dental pathology especially in pericervical region, every lateral tooth was calculated as having 7 surfaces and the frontal teeth as having 6 surfaces, the buccal and lingual being divided in two fields, pericervical part of the surface and a remaining part of crown's surface, for a total 212 tooth surfaces. The level of the interexaminer agreement was very high based on an assessment of a sample of 20 patients ($\kappa = 0.96$).

The statistical analysis was performed using the Student's t-test, chi χ^2 test and analysis of variance in Microsoft Excel 7.0 (Redmond, USA) software. P values lower than 0.05 were considered significant.

Results

The Student t-test showed no significant difference of the oral hygiene index when comparing nondiabetics with the insulin-dependent and non insulin-dependent diabetics. The mean value of the oral hygiene index among nondiabetics was 1.58 ± 0.26, in type I diabetics 1.73 ± 0.35 and in type II diabetics 1.66 ± 0.32; $p > 0.05$. The number of tooth brushing per day for nondiabetics (1.98 ± 0.35) is roughly equal to the daily frequency among all diabetics (1.75 ± 0.27), and the t-test did not show a significant difference ($p > 0.05$). Most examinees in all three groups brush their teeth twice a day. The survey of DMFS distribution among the groups is shown on Figure 1.

The statistical comparison of DMFS index by χ^2 test in various groups revealed significantly higher mean DMFS index matching nondiabetics vs. type I + type II diabetics ($p = 0.031$), nondiabetics vs. type I diabetics ($p = 0.036$), nondiabetics vs. type II diabetics ($p = 0.022$) and nondiabetics vs. all diabetics with Hb A1 > 10% ($p = 0.012$). No significant difference was found comparing the DMFS index in type I vs. type II diabetes ($p = 0.843$), 55 diabetics with HbA1 < 10% vs. 29 diabetics with HbA1 > 10% ($p = 0.410$) and nondiabetics vs. diabetics with HbA1 < 10% ($p = 0.093$).

Comparing the localization of dental caries over identical surfaces (diabetics to nondiabetics) the most pronounced difference in terms of an increased prevalence was found on the buccal cervical surfaces of the upper lateral jaw ($p = 0.002$) and labial cervical surfaces of the lower frontal jaw ($p = 0.001$) among diabetics. Investigating caries by penetration in dental tissue, the increased mean number of deep caries lesions was found particularly in type I diabetics matched to nondiabetics ($p > 0.05$). The dietary habits revealed that over 80% of type I and type II diabetics have 6 meals daily while nondiabetics mostly consume 3–5 meals.

Table 1 shows the daily quantity of basic nutrients and energy intake among all three groups of examinees. Insulin-de-

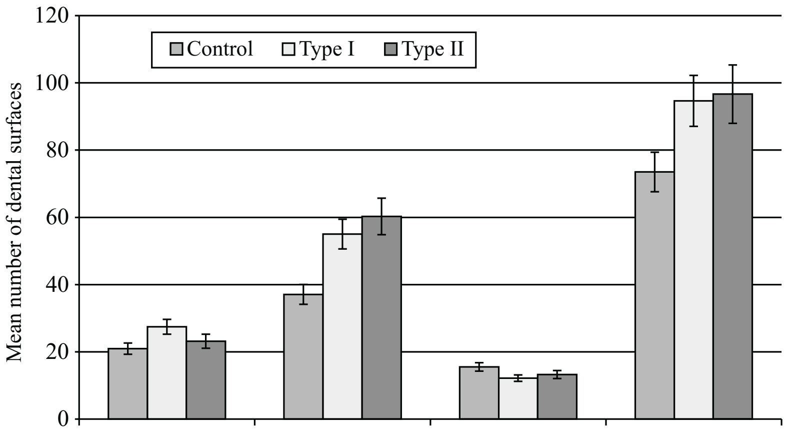

Fig. 1. Mean DMFS-index. DS = decayed dental surface; MS = missing dental surface; FS = filled dental surface; DMFS = sum of decayed, missing and filled dental surfaces.

TABLE 1
DAILY QUANTITY OF BASIC NUTRIENTS AND ENERGY INTAKE AMONG ALL THREE GROUPS OF EXAMINEES

	Proteins (g)	Fats (g)	Carbo-hydrates (g)	Starch (g)	Sugar (g)	Fibers (g)	Energy (kJ; kcal)
Nondiabetics	89.63	140.48	207.15	110.32	93.28	16.33	10180;2433
Diabetics (IDDM)	99.73	116.88	179.27	123.74	55.48	24.09	8989;2145
Diabetics (NIDDM)	86.49	87.99	159.70	88.13	71.57	24.48	7391;1760

pendent diabetics take the greatest quantities of protein while the intake of fats and carbohydrates is greatest among nondiabetics. The significant difference ($p < 0.05$) is found in the quantity of total as well as simple carbohydrate intake between the groups of nondiabetics and all diabetics and separately between nondiabetics and diabetics type I and type II. Both types of diabetics have a higher daily fibber intake than nondiabetics (24.20 ± 1.7 vs. 16.33 ± 1.3 g; $p = < 0.05$). In spite of the greater number of meals, the diabetics consume a smaller quantity of food with a lower energy value.

Figure 2 shows the distribution of daily meals with simple carbohydrates in all three groups of patients. It is evident that over 70% of diabetics have 5 meals daily with simple carbohydrates present, mainly fructose and lactose, while among the nondiabetics the simple carbohydrates are in the greatest percentage distributed in 3–4 meals.

Figure 3 show daily distribution of meals consumption. The difference in the number of meals with simple carbohydrates is significant between both groups of diabetics and nondiabetics (4.8 ± 0.4 vs. 3.4 ± 0.3; $p < 0.05$).

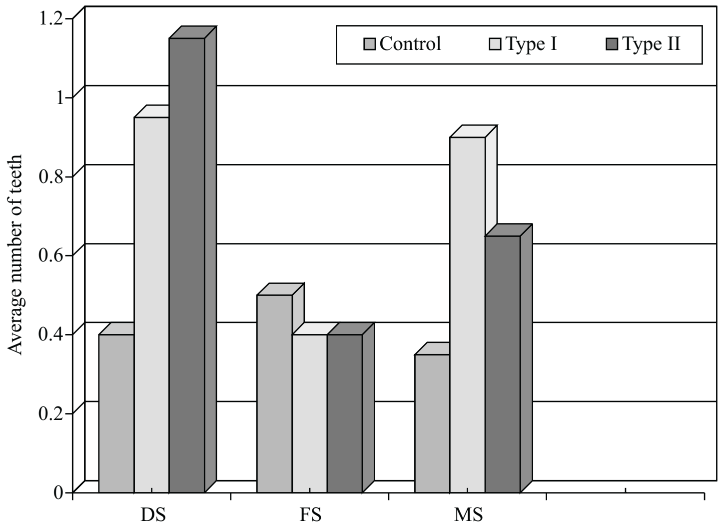

Fig. 2. Daily distribution of meals containing low molecula carbohydrates. DS = decayed dental surface; MS = missing dental surface; FS = filled dental surface; DMFS = sum of decayed, missing and filled dental surfaces.

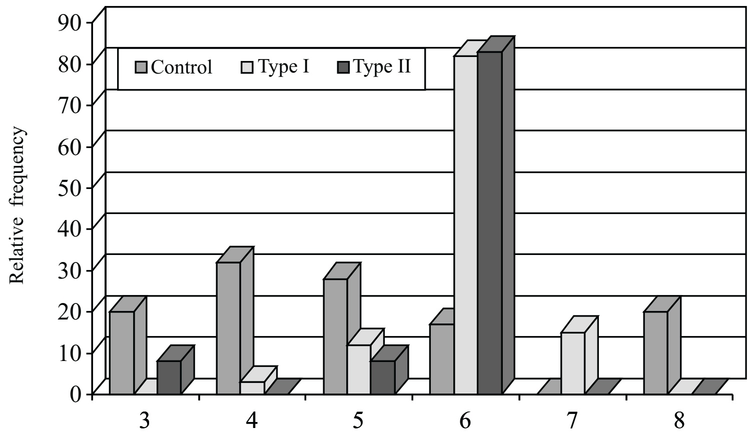

Fig. 3. Daily distributions number of meals. DS = decayed dental surface; MS = missing dental surface; FS = filled dental surface; DMFS = sum of decayed, missing and filled dental surfaces.

In analyzing the daily calcium and phosphorus intake in milligrams and the relation of Ca/P among diabetics and nondiabetics a considerable difference among nondiabetics (Ca = 887.95 ± 75.24; P = 1301.32 ± 93.54), and insulin-dependent patients (Ca = 122.79 ± 86.75; P = 1496.51 ± 102.87) as well as non insulin-dependent diabetics (Ca = 971.5 ± 78.91; P = 1271.95 ± 98.65) was found ($p < 0.05$) (Table 2). The ratio of calcium and phosphorus is considerably lower among nondiabetics than diabetics (0.68 vs. 0.75; p = < 0.05).

TABLE 2
THE DAILY QUANTITY OF MICRONUTRIENT CALCIUM AND PHOSPHOR

	Ca-Mg	P-Mg	Ca/P
Nondiabetics	887.95	1301.32	0.68
Diabetics (IDDM)	1122.79	1496.51	0.75
Diabetics (NIDDM)	971.5	1271.95	0.76

Discussion

The results of our study have not shown a significant difference of oral hygiene between nondiabetics and both types of diabetics. Other authors[6,14] have been investigate problems of oral hygiene in diabetics recording the frequency of daily tooth brushing and have not found any significant difference in this preventive procedure compared to nondiabetics. The exception was Glavind et al.[15] who recorded significant difference on behalf of nondiabetics ranging in age from 20–30 years old. On the other hand Jones et al.[16] found a higher level of oral self-care among diabetics. Because of the nature of disease itself the frequency of food ingestion among diabetics is higher, making the results of our research of the oral hygiene seem more convincing.

In analyzing the caries prevalence on the teeth surfaces (DMFS) a significant difference was found among all the three groups of examinees, the diabetics having more caries than nondiabetics, especially those poorly-controlled which corresponds with the results achieved by some investigators[16,17], but contradicts the results of those researching diabetic children[14]. Other authors did not find important differences in dental health between well-controlled diabetics and nondiabetics[18,19].The cariogenic effect of refined carbohydrates and a significantly higher glucose content in the saliva and gingival fluid of diabetics[20,21] has led us to pay special attention to the cervical area cause of the eventually higher possibility of caries appearing there[22]. Really significant higher caries frequency has been located buccocervically in the upper lateral jaw as well as in the labiocervical surfaces of the frontal part of lower jaw among all diabetics in comparison with nondiabetics. As diabetes is partly an inherited disease, Noren's findings[23] about frequent occurrence of hypoplastic teeth in children of diabetic mothers offer a possible explanation for higher frequency of cervical caries found. This is connected with a hypomineralization of the cervical part of primary teeth. A hypomineralization of the cervical region of permanent teeth in diabetics is also possible if the disease starts early.

The analysis of basic nutrient intake among diabetics and nondiabetics by the 24-hour recall method shows a significantly higher intake of total and low-molecular carbohydrates among nondiabetics. From a great number of epidemiological investigations, animal experiments and controlled human studies a close connection between the sugar intake and the incidence of caries can be deduced [4,24]. Imfeld et al.[4] and Mundorf et al.[4] quote a significantly higher cariogenicity of simple carbohydrates, Rugg-Gunn et al.[2] point out a significant cariogenicity of lactose from milk, one of the main alimentary articles of diabetics, while Pollard[25] draws attention to the neglected but considerable cariogenicity of starch. Stanton[26] quotes the results of the investigations about a calcium phosphorus ratio in the diet of adults on a series of 200 examinees showing a significantly lower caries activity at a quotient of 0.50–0.67, while in higher quotients a progressively higher incidence of caries is found. Among our nondiabetics the calcium phosphorus ratio in diet was 0.68, which is just little above the mentioned values, while the ratio in diabetic diet was significantly higher. This fact could contribute to a cariogenic predisposition of diabetics because of an unfavorable ratio of to the teeth important minerals in nutrition. Honkala et al.[27] stress the importance of dietary habits, kind of meals, the frequency of feeding and the number of daily ingestion of sugar between meals in relation to the caries incidence.

The results of our investigation regarding the number of meals and the frequency of sugar presence in daily meals point to a significantly higher number of daily meals among diabetics as well as a more frequent presence of simple carbohydrates in the daily meals of diabetics favoring to the metabolism of cariogenic microorganisms[28]. In analyzing the presence of simple carbohydrates in daily meals it has been taken in consideration that many alimentary products in normal meals contain a part of hidden sugars (fruits, beverages, white bread, milk products, vegetables etc.). The possible pathogenic principles due to which a considerably higher incidence of dental caries was found are the higher frequency of daily meals with the presence of low-molecular carbohydrates matched with the same frequency of daily tooth brushing as in nondiabetics and improper calcium phosphorus ratio in the diet.

The prevention of dental caries among diabetics should include a good control of diabetes mellitus, more frequent daily tooth washing, the correction of the calcium phosphorus ratio in the nutrition and more frequent stomatologic control.

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UTJECAJ PREHRANE NA ZUBNI KARIJES KOD DIJABETIČARA

SAŽETAK

Dvije skupine ispitanika podjednake dobi od kojih 84 ima dijabetes (60 tipa I i 24 tipa II) a 69 su nedijabetičari ispitivane su kako bi se utvrdio: indeks oralne higijene (OHI), učestalost dnevnog četkanja zubi, prehrambene navike i učestalost zubnog karijesa bilježeći kariozne, ekstrahirane i liječene zube (DMFS-indeks). Utvrdilo se kako je OHI kod dijabetičara tipa I i II dijabetesa nešto lošiji nego kod nedijabetičara ali ne statistički značajno ($p > 0{,}05$). Nije utvrđena statistički značajna razlika u učestalosti četkanja kod dijabetičara u odnosu na nedijabetičare. Svi dijabetičari imali su niži unos složenih i jednostavnih ugljikohidrata u odnosu na nedijabetičare. Kod dijabetičara utvrđen je statistički značajno veći unos vlakana, kalcija i fosfata, veći broj obroka jednostavnih ugljikohidrata kao i veći DMFS-indeks nego kod nedijabetičara. Statistički značajno veća učestalost karijesa ($p < 0{,}01$) na bukalnim i labijalnim cervikalnim područjima utvrđena je kod bolesnika s dijabetesom. Ovaj nalaz moguće je objasniti većom učestalošću dnevnog unosa niskomolekularnih ugljikohidrata s nedostatnim udjelom kalcija i fosfata.

Discussion

The study group of patients was not selected on the basis of any radiographic or medical criteria, which would define an individual as 'normal' or 'osteoporotic' and was not chosen from any particular dental specialty. The group therefore represented a typical range of older female and male patients, drawn from the Department of Prosthodontics within the School of Dental Medicine, University of Zagreb, Croatia, who had undergone a DPR examination as part of the prosthetic treatment.

In this study none of the patients had category 1 of MCI, which was attributed to the relatively aged group of the patients (the youngest had 48 years and next age was 52 years) and it is well known that the first signs of bone loss start at the age of 30 years[26].

The results reported by Ledgerton at al.[23] indicated the significant, negative correlation of the quantitative indices (GI, MI, AI and PMI) with age. The results of their study also showed the age-related distribution of MCI, therefore, it was reassuring to see an age-related increase in the numbers of individuals with C3 appearances, presumably reflecting age-related bone loss[23], which is also proved by the results of this study (Figures 4 and 5). However, the results of this study, also reflected gender and age bone loss, with C3 showing significantly higher incidence in females of the oldest age group ($p < 0.05$; Figures 4 and 5).

The relative proportions of the three MCI classes on the age groups from 45 to 54 years in Legerton's study[23] were similar to those reported by Klemetti[14] in their study of 355 Finnish women (48–56 years). However, Taguchi at al.[27] identified a far greater proportion of C1 cortices in their study of 124 Japanese women in a broad age band (33–68 years). This may reflect ethnic differences or a difference in the interpretation of the definitions of the MCI groups, or could be attributed to the fact that younger age group participated in the study.

It may be that a modification of MCI by dividing C3 into early and late C2 changes would improve the classification because the main discrepancy occurred in those who lay on the border of two categories (C1/C2 of C2/3)[23].

Some previous studies are confirming the negative correlation of GI with age[22,23,28–30], which was also confirmed in this study, both for age and gender ($p < 0,05$; Figure 3).

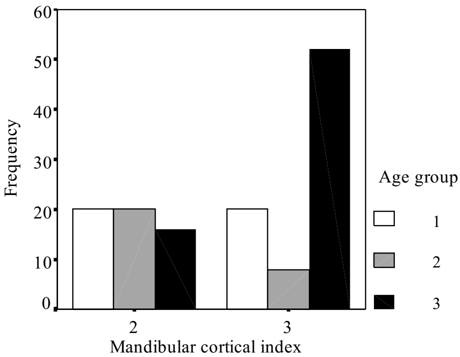

Fig. 4. The frequency of the mandibular cortical indeks categories (C1, 2 and 3) related to age group of patients. Age groups: 1 = less than 65 years, 2 = 65–75 years, 3 = more than 75 years.

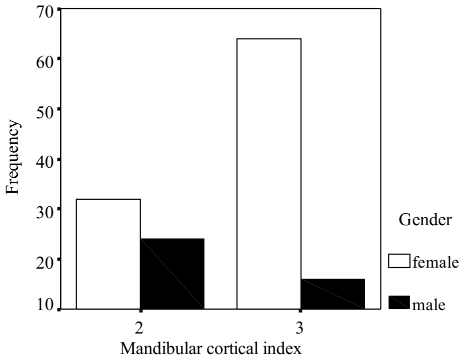

Fig. 5. The frequency of the mandibular cortical indeks categories (C1, 2 and 3) related to gender of patients.

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