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IZVORNI ZNANSTVENI ČLANAK
ORIGINAL SCIENTIFIC PAPER

EFFECTIVENESS OF DIFFERENT PREVENTIVE PROCEDURES IN THE CONTROL OF CARIOGENIC RISK FACTORS IN CHILDREN

HRVOJE JURIĆ, IVANA ČUKOVIĆ-BAGIĆ*

Caries risk assessment is a valuable clinical procedure that in many ways facilitates implementation of preventive procedures in children with high risk of caries. The aim of this study was to investigate the effectiveness of five different caries preventive procedures in vivo. One hundred children, aged 4-5 and 10-12 years, were divided into five groups (20 per group) and treated with different preventive procedures (amine fluoride solution, professional prophylactic paste, chewing gum containing xylitol and fluoride, chlorhexidine solution, or chlorhexidine-fluoride gel). During a period of two months, five measurements were performed and the following variables evaluated: Streptococcus (S.) mutans and lactobacilli count (LB), oral hygiene index (OHI), and amount of stimulated saliva. Results showed the highest reduction in the number of bacteria to be achieved by the application of professional prophylactic tooth paste and daily use of chewing gum containing xylitol and fluoride ($p<0.001$). In these children, S. mutans count was reduced by class 1 and LB to $<10^4$ CFU/mL after two months. In conclusion, professional tooth cleaning and use of chewing gum with xylitol and fluorides on a daily basis could be very effective protocol in controlling caries risk factors in children.

Descriptors: CHILD; DENTAL CARIES; FLUORIDES, TOPICAL; CHLORHEXIDINE; CHEWING GUM; XYLITOL

INTRODUCTION

Over the last few decades, the average incidence of caries in schoolchildren has steadily decreased (1). However, regardless of this fact, a number of schoolchildren have great difficulties with caries, which represents a serious health problem. Such a phenomenon is known as caries polarization, where 20%-30% of the pediatric population develop between 75% and 85% of carious lesions recorded in the study population (2, 3). Because of the multifactorial causes of caries, recognition of such patients poses a major problem and hinders development of an effective model that would be simple to apply and accurate in identification of such patients in the total population (4-6). It is of the utmost importance to ensure that intensive individual prevention of caries be effective over a longer period of time, especially in children with an increased risk of caries (7). It should be noted that there are contrary opinions on the effectiveness of intensive prevention in case of high risk patients (8).

Today, a large number of caries predictors are identified: *Streptococcus (S.) mutans* (SM) and lactobacilli salivary count, diet, oral hygiene habits, lack of fluoride application, prolonged lactation, socioeconomic status, race, sex, age, amount of stimulated saliva, plaque index, and metabolic plaque activity (9-11). All these factors have, more or less, influence on caries development. Although some authors emphasize that *S. mutans* and lactobacilli salivary count has little predictive value for caries occurrence (12, 13), there is still considerable evidence that these data can accuratly identify patient with high risk for caries development (14, 15). Such data increase in value when other caries risk factors are assessed in the same patient, such as past caries experience, visible plaque index, or the amount of stimulated saliva. By controlling the aforementioned factors, good caries preventive effect can be expected.

The aim of this study was to assess the caries-preventive value of preventive methods *in vivo* through their effect on caries predictors, such as *S. mutans* and lactobacilli salivary count, visible plaque index, and amount of stimulated whole saliva.

MATERIALS AND METHODS

The sample consisted of 100 children, all patients of the Department of Pediatric and Preventive Dentistry, School of Dental Medicine, University of Zagreb, Croatia, aged 4-5 and 10-12 years. Prior to their inclusion in the study, the patients' parents signed an informed consent form and the study was approved by the Zagreb School of Dental Medicine Ethics Committee. Children were clinically examined by an experienced pediatric dentist (intra-examiner kappa value, 0.85), on a dental chair, using a dental mirror and probe. All children followed the same oral hygiene procedure twice a day, with identical tooth

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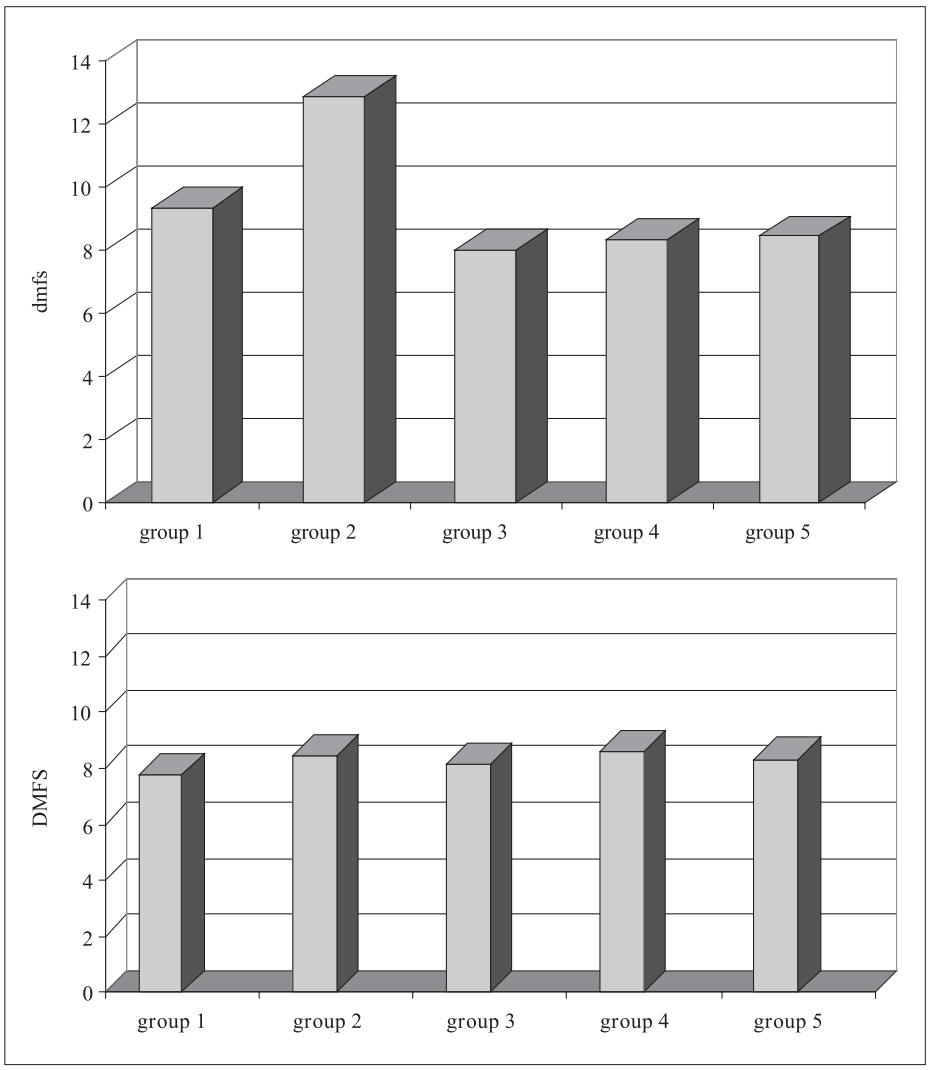

Figure 1. *Mean dmfs and DMFS index values in both groups*
Slika 1. *Prosječne vrijednosti dmfs i DMFS indeksa u obje skupine*

brushes and fluoride tooth pastes. None of the children received antibiotic therapy during, and at least 2 months before the study.

The children were randomly divided into five groups of 20 age-matched subjects with the same age distribution, ten younger (4-5 years) and ten older (10-12 years) subjects *per* group. Caries (dmf-s and DMF-S index) was assessed by standard methods and World Health Organization (WHO) criteria (16) for estimating the past caries experience in the study groups.

In group 1, 0.5 mL of amine fluoride solution with 10000 ppm F (elmex® fluid, GABA International, Switzerland) was used. The solution was applied with a cotton pellet only once during the study, directly to the surfaces of all teeth. In group 2, the professional prophylactic paste Proxyt (RDA 36) (Ivoclar Vivadent, Schaan, Liechtenstein) was applied with a synthetic brush on a slow-speed hand piece at an average speed of 2000 rpm after first clinical data collection. Beside, the abrasive elements, Proxyt paste contains two active ingredients, 0.05% of fluorides in organic form (cetalamine hydrofluoride) and xylitol. In group 3, the prophylactic paste Proxyt was applied by the same protocol as in group 2, with the additional use of Sensodyne chewing gum (Block Drug Inc., Ratingen, Germany) containing xylitol and fluoride. During the first week after the basic procedure, children were chewing five chewing gums *per* day, after every evening meal. During the second week, children were chewing three chewing gums *per* day, one after each meal. From the third week to the end of the study, children were chewing only one chewing gum *per* day, every evening after meal. Chewing was restricted to 10 minutes for each chewing gum. In group 4, chlorhexidine solution conc. 0.2% was used. Chlorhexidine solution (Corsodyl, GlaxoSmithKline, UK) was applied daily for five days (0.5 mL *per* day). Chlorhexidine solution was first applied in dental surgery after the first measurement by means of a small cotton pellet, and later applications were done at home with a tooth brush after cleaning the teeth in the evening for 2 minutes. Group 5 children were treated with Cervitec gel (Ivoclar Vivadent, Schaan, Liechtenstein) containing 0.2% chlorhexidine and 900 ppm fluoride. 0.5 mL of Cervitec gel was applied each evening after regular tooth brushing, using a tooth brush for 2 minutes.

Five measurements were performed: prior to the preventive procedure, 30 minutes, 7 days, 1 month and 2 months after the preventive procedure. Each measurement consisted of determining of the salivary count of *S. mutans* and lactobacilli, amount of stimulated saliva and Oral Hygiene Index (OHI) according to Green-Vermillion (17) .

Salivary count of *S. mutans* and lactobacilli was determined by the chair-side dip-slide test CRT Bacteria (Ivoclar Vivadent, Schaan, Liechtenstein) following the manufacturer's instructions. *S. mutans* count was expressed in grades 0 to 3, i.e. values of less than 10^4 (class 0) to up to values of more than 10^6 (class 3) CFU/mL of whole saliva. Salivary count of lactobacilli was expressed as 10^3-10^6 CFU/mL saliva. Visible plaque was stained by Plaque Test (Ivoclar Vivadent, Schaan, Liechtenstein).

Statistical analysis was performed using SPSS for Windows 12.0. Non-parametric Kruskal-Wallis test was used for the statistical analysis of the results and ANOVA for repeat measurements. Between-group distribution differences were tested by the χ^2-test.

RESULTS

Past caries experience. DMF-S and dmf-s indexes presented in Figure 1 revealed the study sample to have a high risk of caries and similar distribution of higher risk children across the groups. On initial measurement, there were no significant differences in *S. mutans* count, lactobacilli count, OHI and amount of stimulated saliva. Moreover, the mean values and standard deviations were almost equal indicating that the groups were

uniform before the preventive procedures.

All patients had a relatively high *S. mutans* saliva count on the initial saliva sampling, of 2.5 or more on an average, which represents a very high number of cariogenic bacteria in 1 mL of saliva and consequently an increased risk of caries. After the application of preventive procedures, the number of bacteria decreased, and thus each of the examined methods demonstrated its preventive effect. In group 1, no effect of Elmex® fluid was observed after one week. In group 2, the antibacterial effect persisted for 30 days. The longest preventive effect was observed in group 3, with highly significant ($p<0.001$) reduction of *S. mutans* at the third measurement to the end of the study. At the end of the study, this group showed the best overall result. Chlorhexidine solution and chlorhexidine fluoride gel showed very good antibacterial effect, although it significantly diminished from measurement to measurement during the study (Figure 2).

In groups 1 and 4, the number of lactobacilli was not effectively reduced, indicating minimal antibacterial effect of amine fluoride and Corsodyl solutions on these organisms. Proxyt paste proved to have the greatest antibacterial effect on lactobacilli, particularly in combination with chewing gum. Prior to the preventive procedure, the average number of lactobacilli in all five study groups amounted to approximately 10^5 CFU/mL of saliva. After the third measurement, a significant reduction was found in group 3 ($p<0.001$) and was maintained to the end of the study (Figure 3).

The visible plaque index was measured according to Green-Vermillion. Measurement results for each examination are shown in Figure 4. The best results were achieved with Proxyt paste and chewing gum, showing statistically significantdifference ($p<0.001$) as early as the second measurement, with notable reduction in plaque index.

Figures 5 and 6 show the mean values of the amount of stimulated saliva for younger and older subjects in mL/5 minutes. Older subjects produced between 0.6 and 0.9 mL stimulated saliva in one minute, which are almost normal values for adult patients, whereas younger subjects produced between 0.5 and 0.6 mL stimulated whole saliva in one minute. With regard to this result, it is interesting to note that salivation increased steadily throughout the study in the subjects who were daily chewing gum.

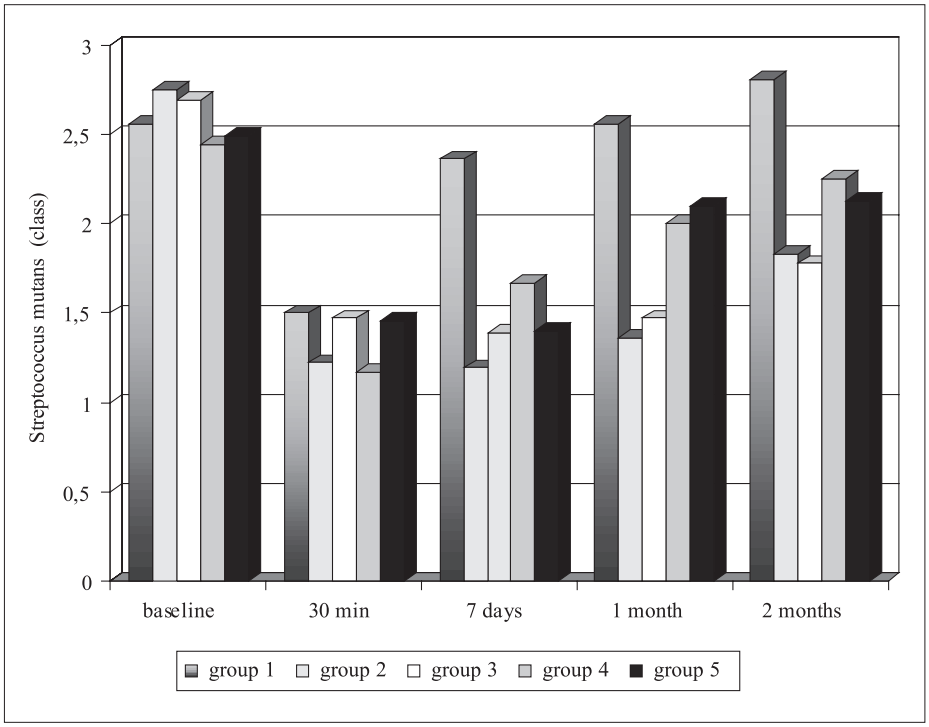

Figure 2. *Mean Streptococcus mutans count*
Slika 2. *Prosječan broj Mutans streptokoka*

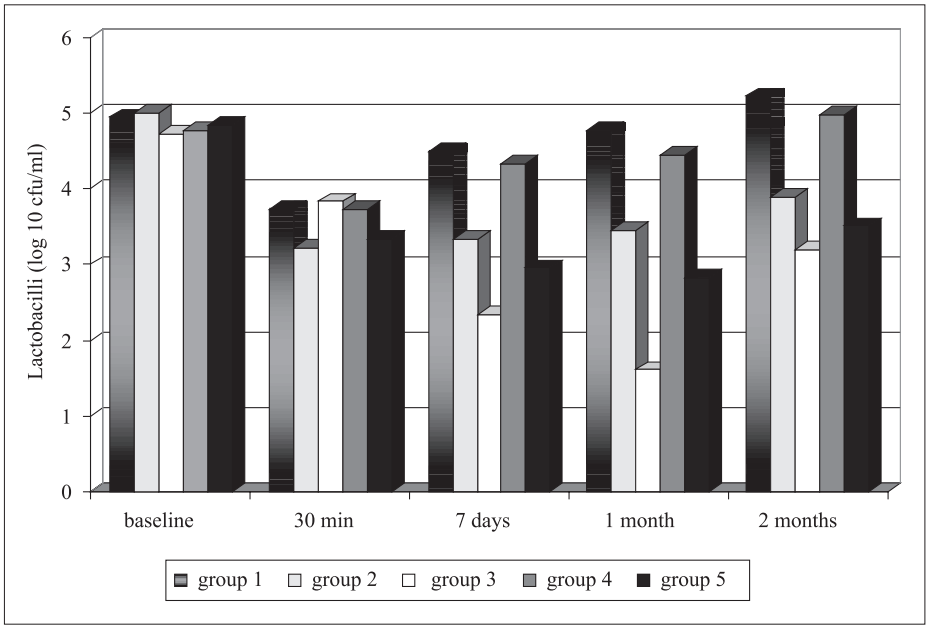

Figure 3. *Mean Lactobacillus count*
Slika 3. *Prosječan broj Laktobacila*

DISCUSSION

The aim of the study was to assess effectiveness of different caries preventive methods in routine clinical conditions. Also, the intention was to gain new knowledge according to which protocol specific caries preventive methods should be applied in order to achieve optimal protective effect through bacterial flora reduction and salivary flow stimulation. In this way, it would also be possible to select the best clinical procedure with regard to cost and efficacy.

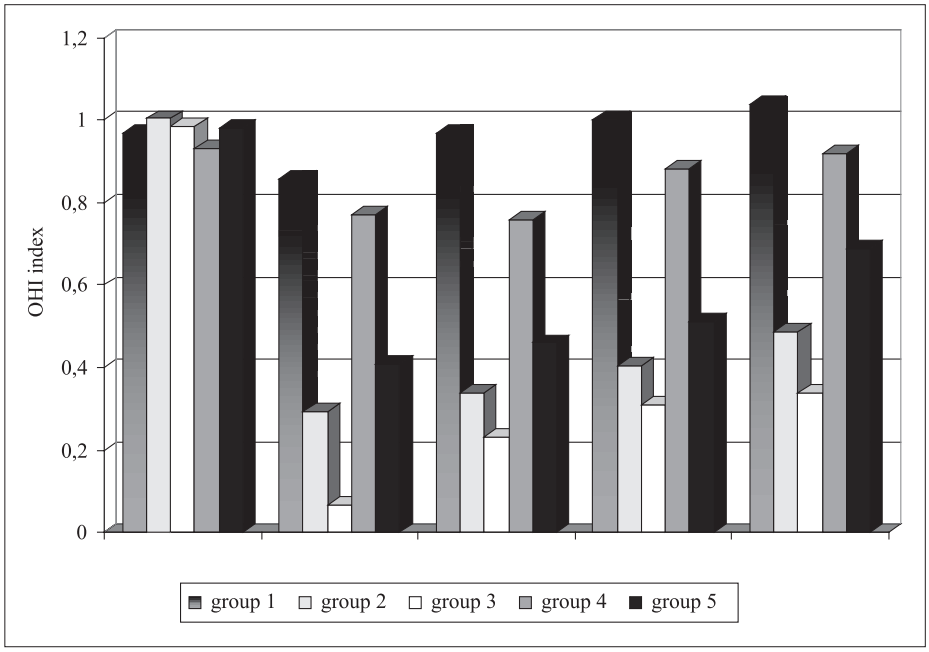

Figure 4. *Oral hygiene index (OHI) values*
Slika 4. *Vrijednosti OH indeksa u obje skupine*

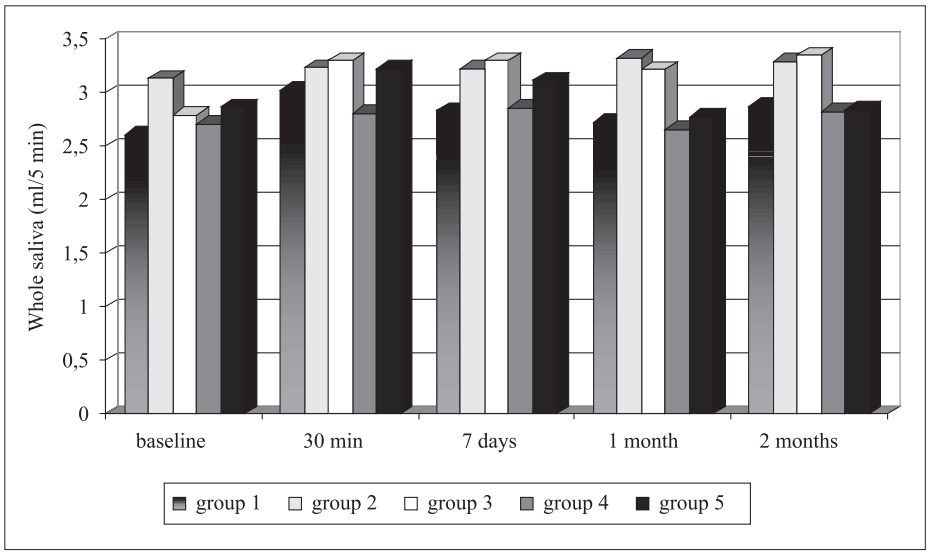

Figure 5. *Mean amount of stimulated saliva in children aged 4-5 years*
Slika 5. *Prosječna količina stimulirane sline u djece u dobi od 4-5 godina*

We found a relatively high dmf-s or DMF-S index in all study groups (from 7.67 to 12.89). Such a level of oral health ranks us in the lower third of the European average (3). At the same time, such results justify our efforts to promote a more effective caries prevention program.

Bacterial analysis was performed on stimulated saliva. The reliability of this method as a reference value in epidemiological studies has frequently been discussed in the literature. However, many studies have shown a statistically significant correlation between the number of bacteria in plaque and saliva (18). Moreover, some investigations support the fact that dental plaque specimen does not explain variation in the prevalence of caries better than data obtained from stimulated whole saliva (19). Comparative studies between commercial kits for determining the number of *S. mutans* based on dipslide tests and conventional plate counts confirmed statistically significant correlation of these two methods (20, 21). Thus, the method used in our study can be recommended because of its simple clinical use and reliability.

To reduce the number of *S. mutans* over a longer period is a very hard task. During our two-month study, the best results were achieved with Proxyt tooth paste combined with daily use of chewing gum containing xylitol and fluoride. We believe that this result, with a reduction by 1 class from 2.5 to 1.5 during the period of two months can partly be attributed to the additional favorable effect of chewing gum, both through the mechanical and stimulating effect and the effect of xylitol. Our results are consistent with other literature reports (22-24). The effects of fluoride are also multiple. Apart from remineralization, fluorides also have a specific effect on the inhibition of dental plaque formation and metabolism (25-27).

Control of the number of Lactobacilli showed a slightly greater regularity. All results, which remained at the level of less than 10^4 CFU/mL of stimulated saliva, could be considered as favorable caries preventive effects. The results obtained in our study were comparable with those reported elsewhere (14, 28). It should be emphasized that the preventive procedure used in group 3 showed the best reductive effect on the bacterial count with slightly more than 10^3 CFU/mL of stimulated saliva.

Decrease of the OHI value recorded during the study was a very important factor, which demonstrated the effectiveness of the preventive procedures used. In group 3, the best results were obtained as early as the second preventive treatment, with a statistical significance ($p<0.001$), which were maintained to the end of the study. At the end of the study, the decrease of the OHI in group 3 was around 65, clearly identifying the most effective preventive procedure used in the study. In similar studies, results of plaque reduction were slightly lower, which in this case can be explained by the additional reductive effect of professional prophylactic paste (29, 30).

The favorable effect of increased salivation is desirable for any method of caries prevention. During the study, a mean increase by 0.1 mL/min occurred in the group using chewing gum yielding approximately 150 mL daily or 13%-15% of total daily salivation. Our opinion is that this effect is also highly valuable for caries prevention. Our results are comparable and consistent with the results reported by other investigations on the use of chewing gum (31). A short-term positive effect of

increase in salivation was also observed in group 1, confirming earlier results of other authors on the stimulating effect of amine fluoride on salivation as an additional caries preventive effect (32).

The recognition of patients with high caries risk is an important precondition for the choice and application of an efficient preventive procedure. We conclude that the application of CRT Bacteria tests represents a simple clinical procedure, which enables detection patients high risk of caries and at the same time provides some guidelines for the preventive procedure that can ensure appropriate disease prevention. The preventive procedures used professionally in the dental practice and at home should be based to estimate of the degree of caries risk. The results of this study indicated that professional cleaning and polishing of the teeth with Proxyt paste in combination with daily use of chewing gum containing xylitol and fluoride could provide very effective control of important caries risk factors. Through these conclusions, we can expect good protection effect from the presented caries preventive regimens in the time to come, especially for high caries risk patients.

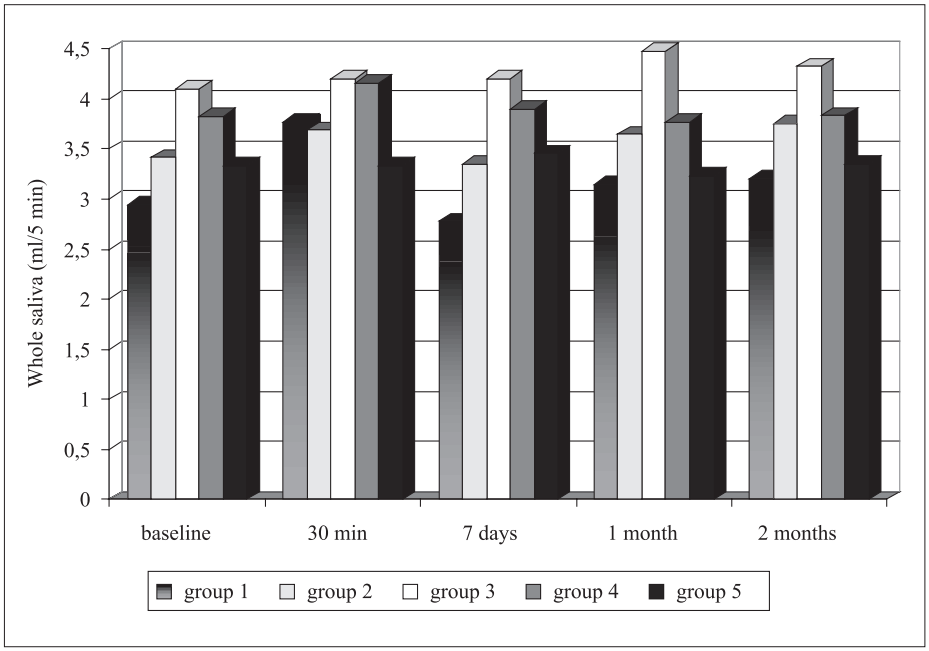

Figure 6. *Mean amount of stimulated saliva in children aged 10-12 years*
Slika 6. *Prosječna količina stimulirane sline u djece u dobi od 10-12 godina*

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S a ž e t a k

DJELOTVORNOST RAZLIČITIH PREVENTIVNIH POSTUPAKA U KONTROLI KARIOGENIH RIZIČNIH ČIMBENIKA U DJECE

H. Jurić, I. Čuković-Bagić

Procjena rizika za razvoj karijesa vrijedan je klinički postupak koji u mnogočemu olakšava uvođenje preventivnih postupaka u visokorizične djece za karijes. Cilj ovog istraživanja bio je ispitati djelotvornost pet različitih karijes preventivnih postupaka in vivo. Stotinu djece, razdijeljene u pet skupina, od kojih je u svakoj bilo 20-ero (u dobi od 4-5 i od 10-13 godina) tretirano je različitim preventivnim postupcima (amin fluoridnom otopinom, profesionalnom profilaktičkom pastom, žvakaćom gumom koja sadrži ksilitol i fluorid, otopinom klorheksidina, gelom koji sadrži klorheksidin i fluor). Tijekom dvomjesečnog razdoblja obavljeno je pet mjerenja i evaluirane su sljedeće varijable: broj Streptococcus mutans (SM) i Lactobacilli (LB), indeks oralne higijene (OHI) i količina stimulirane sline. Rezultati su pokazali da je najveće smanjenje broja bakterija postignuto primjenom profesionalne profilaktičke paste i svakodnevnim žvakanjem žvakaće gume koja sadrži ksilitol i fluorid ($p<0.001$). Kod te djece nakon dva mjeseca broj SM-a smanjen je na klasu 1 i LB-a na $<10^4$ CFU/ml. Zaključno, profesionalno čišćenje zuba i upotreba žvakaće gume s ksilitolom i fluoridima na dnevnoj bazi mogla bi biti vrlo djelotvorni način za kontrolu rizičnih čimbenika za nastanak karijesa u djece.

Deskriptori: DIJETE; ZUBNI KARIJES; AMIN FLUORIDNA OTOPINA; KLORHEKSIDIN; ŽVAKAĆA GUMA; KSILITOL

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