THE EFFECT OF USING TOOTHPASTE WITH HIGH AND STANDARD FLUORIDE CONTENT ON DEMINERALIZATION LESIONS IN TOOTH ENAMEL

Elżbieta Pels[1], Karol Jankowski[2],
Maria Mielnik-Błaszczak[1], Dorota Krawczyk[1]

[1] *Department of Developmental Age Stomatology, Medical University of Lublin*
[2] *Doctoral Studies at the Department of Developmental Age Stomatology, Medical University of Lublin*

Abstract

Introduction. The regular use of fluorides is the best documented and the most efficient method of preventing dental caries.

Aim. The study objective was to analyse the effect of using toothpaste with high and standard fluoride content on the mineralization level in tooth enamel.

Material and methods. The number of 68 patients were enrolled in the study, including 54.41% subjects in the study group, and 45.59% subjects in the control group. The mean age in the study group was 25.87 years, and in the control group – 21.35 years. The patients who used a toothpaste with high fluoride concentration were qualified to the study group, while the control group comprised patients who used a standard toothpaste. Demineralization lesions were examined in the study subjects with the use of the DIAGNOdent device. The lesions were qualified to the study with the use of the ICDAS II scale.

Results. Comparing the first and the third study in the whole population of the study subjects, differences were shown in the demineralization lesion no. 1 (p=0.001*), demineralization lesion no. 2 (p=0.040*) and demineralization lesion no. 3 (p=0.027*).

As for demineralization lesion no. 1, as many as 41 subjects had a significantly lower DIAGNOdent score in the study 3, after 2 months of using the toothpaste, than in the preliminary study 1. As for demineralization lesion no. 2, the number of 33 subjects had a significantly lower DIAGNOdent measurement in study 3 than in study 1. As for demineralization lesion no. 3, as many as 36 subjects had a lower DIAGNOdent measurement in the study 3 than in the study 1. As for demineralization lesion no. 4, the number of 25 subjects had a lower DIAGNOdent measurement in the study 3 than in the study 1.

Conclusions. DIAGNOdent readings indicate a significantly more frequent remineralization effect of using a high-fluoride toothpaste as compared to toothpaste with standard fluoride content. The finding may be used in prophylactic and therapeutic activities in the first stage of demineralization lesions of tooth enamel.

Keywords: dental caries, preventions, fluoride, DIAGNOdent.

Introduction

The basic form of preventing dental caries is proper hygiene, proper nutrition, use of fluoric preparations and regular visits at the dental office. Brushing of tooth surfaces is the basic and the most important hygienic procedure. If properly performed, the procedure enables removal of most dental plaque, except for that with difficult access and the mineralized one [1].

Regular use of fluorides is the best documented and the most efficient method of preventing dental caries. The World Dental Federation (FDI) and the World Health Organization (WHO) recommend the use of preparations containing fluorine as safe and efficient, but they emphasise the necessity to monitor their exposure and to assess their efficacy [2]. On the basis of the questionnaire surveys conducted in 2014 in Poland, 14% of dentist do not analyse the risk of caries before choosing a form of prophylaxis, and more than a half believe that fluoride prophylaxis should be used in every patient [3].

Numerous scientific studies confirm the thesis that fluorides prevent tooth decay and are effective in non-invasive treatment of initial demineralization lesion.

The basic and the most effective method used in home prophylaxis is brushing teeth at least twice a day with a toothpaste containing fluorine (1450-5000 ppm) and using mouthwash with 225-900 ppm F. Brushing should be performed since the moment when the first primary tooth appears and should be monitored by parents until the child is 8 years old. To increase the fluorine effect, rinsing the mouth with water should be replaced by spitting out the toothpaste excess [4].

Toothpastes with high fluorine concentration available in Poland contain 5000 ppm F in the form of sodium fluoride. The core of the toothpaste activity is an increase in the fluorine content in the oral environment in comparison with toothpaste with a standard content of F ions. The toothpaste is recommended in home prophylaxis in subjects above 16 years of age. The toothpaste should be used for a period of from 3 to 6 months, brushing the teeth 2-3 times a day with a strip about 2 cm wide. The target group of patients comprises subjects with a high risk of dental caries, and also, in the case of initial demineralization lesions, subjects treated with fixed braces and subjects with xerostomia [5].

One type of light sources finding its use in diagnosing tooth decay, is laser-induced fluorescence. DIAGNOdent from Kavo is a device based on this method. This device is used for detection of early demineralization lesions in mineralized dental tissues. The system generates a 655 nm laser beam light which is absorbed by organic and inorganic components of the enamel and dentine. A portion of the light is reemitted in the form of infrared fluorescence, whose magnitude depends on the mineralization level of dental tissues. The fluorescence is analysed by a microprocessor and the result is given in the form of a number and sound signal. The numerical result is given in a 0-99 scale without a specific unit, in the range with instantaneous and maximum value. The assessment is typically based on the Hibst and Paulus classification which

corresponds to 4 levels, depending on the result: (1) 0-13, (2) 14-20, (3) 21-29, (4) 30-99. The values in the range of:

0-20   – qualify for prophylactic activities,

21-29   – qualify for professional prophylactic procedure or minimal stomatological intervention, depending on the conditions in the oral cavity,

above 30 – qualify for definite treatment procedure.

During operation of the DIAGNOdent device, it is recommended to maintain the temperature around 22°C and to switch off the lamp of the dental unit. The device needs frequent calibration and is sensitive to deposits, contamination and discolouration other than resulting from caries, which may to a significant extent alter the reading. This is a highly sensitive examination which allows recording of structural lesion reaching the depth of 5-8 μm. The assessment of fluorescence, and the microstructural and chemical analysis of tissues provide a lot of information about the process of enamel demineralization [6].

Aim

The study objective was to analyse the effect of using toothpaste with high and standard fluoride content on the mineralization level in tooth enamel.

Materials and methods

The number of 68 patients were enrolled in the study, including 54.41% (n=37) subjects in the study group, and 45.59% (n=31) subjects in the control group. The mean age in the whole group was 23.57±5.17 years old (range from 19 to 53 years old). The mean age in the study group was 25.87 years old, and in the control group 21.35 years old. In the study group, there were 67.57% of women and 32.43% of men, while in the control group there were 70.97% of women and 29.03% of men. Both in the study and control group, the most common place of residence was a big city (83.78% – study group, 67.74% – control group). The characteristics of the study groups is presented in Table 1.

Table 1. Characteristics of the patient groups

Socio-demographic factors		Study group		Control group	
Age	mean ± standard deviation	26.54±6.54 years		21.35±1.68 years	
		N	%	N	%
Sex	Women	25	67.57	22	70.97
	Men	12	32.43	9	29.03
Place of living	Big town/city	31	83.78	21	67.74
	Village	6	16.22	10	32.26
Age	Up to 21 years old	8	21.62	22	70.97
	22-25 years	10	27.03	7	22.58
	Above 25 years	19	51.35	2	6.45

Assessment of demineralization lesions with the use of DIAGNOdent in three stages of the study. As part of the study, 1 to 4 points of demineralization were assessed in each study subject. The lesions were qualified to the study with the use of the ICDAS II scale. Then, each demineralization lesion which had a score of 1-3 using the above-mentioned scale, was subject to clinical assessment with the use of the DIAGNOdent device from KAVO. The study was conducted in 2015-2017.

Patients who used toothpaste with high fluoride concentration were qualified to the study group, while the control group comprised patients who used standard toothpaste.

The study was carried out in three stages:

examination 1 – initial on one visit,

examination 2 – after one month,

examination 3 – two months after starting the application of the tested paste.

High-fluoride paste and standard paste were used for 5 minutes. The study and control groups comprised employees and students of the Medical University of Lublin.

Only the subjects who gave their consent and filled in a questionnaire took part in the clinical trial. Demineralization lesions were examined in the study subjects with the use of the DIAGNOdent device.

The studies had received a positive opinion of the Bioethics Committee of Medical University of Lublin (resolution no. KE-0254/7/2014).

The study results were submitted to a statistical analysis, with calculation of frequency for quality variables and for quantity variables mean values ± standard deviation (SD) or median values; and minimum and maximum values were calculated. Statistical analysis of the verification of statistical hypotheses was based on the U Mann-Whitney test. A 5% accepted conclusion error and $p<0.05$ assumed as the level of significance. The database and statistical analyses were performed with Statistica 10.0 software (StatSoft, Poland).

Results

Assessment of demineralization lesions with the use of DIAGNOdent in three stages of the study. As part of the study, 1 to 4 points of demineralization were assessed in each study subject. The lesions were qualified to the study with the use of the ICDAS II scale. Then, each demineralization lesion which had a score of 1-3 using the above-mentioned scale, was subject to clinical assessment with the use of the DIAGNOdent device from KAVO.

DIAGNOdent measurements in three stages of the study

Demineralization lesion no. 1 in a given patient (reduction/lesion progression)

DIAGNOdent measurements regarding the first examined demineralization lesion in a given patient are shown in Table 2. In the study group, the mean value of DIAGNOdent measurements in the first study was 24.24±13.38, Me=20.00, in the second study 20.63±12.26, Me=17.50, and in the third study 18.63±11.50, Me=16.00. In the control group, the mean value of DIAGNOdent measurements in the first study

was 28.24±14.58, Me=27.00, in the second study 30.14±17.10, Me=28.00, and in the third study 24.03±15.02.

Table 2. DIAGNOdent measurements regarding demineralization lesions no. 1 in a given patient (reduction/progression) in the whole group of patients and in 3 stages of the study

Descriptive statistics	Study group			Control group		
	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3
N	33	32	32	29	28	29
M	24.24	20.63	18.63	28.24	30.14	24.03
Me	20.00	17.50	16.00	27.00	28.00	20.00
SD	13.38	12.26	11.50	14.58	17.10	15.02
Min	7.00	5.00	5.00	7.00	7.00	4.00
Max	54.00	54.00	56.00	68.00	74.00	63.00

N – number of subjects, M – mean, Me – median, SD – standard deviation, Min – minimum value, Max – maximum value

In the study group, no differences between the studies 1, 2 and 3 were revealed regarding teeth in the groups: upper incisors, lower premolars and upper molars (p>0.05). It was revealed, however, that the value of DIAGNOdent measurements was significantly higher in the study 1 than in the studies 2 and 3 (p=0.006*).

In the control group, no differences were revealed for any of the dental groups (p>0.05). In the control group in the study 2, the value shown by DIAGNOdent was higher than in the studies 1 and 3 in the group of lower molars, premolars and upper molars (p=0.019*). Regarding the studies 1 and 2, no differences were shown between the study group and the control group (p>0.05).

Demineralization lesion no. 2 in a given patient (reduction/lesion progression)

DIAGNOdent measurements regarding the second examined demineralization lesion in a given patient are shown in Table 3. In the study group, the mean value of DIAGNOdent measurements in the study 1 was 29.31±20.92, Me=22.00, in the study 2 the mean value was 25.61±19.12, Me=20.00, and in the study 3 the mean value was 26.32±21.61, Me=19.00.

In the control group, the mean value of DIAGNOdent measurements in relation to the second demineralization lesion in a given patient in the study 1 was 33.10±21.70, Me=28.00, in the study 2 it was 29.79±20.62, Me=19.00, and in the study 3 it was 27.69±20.62, Me=19.00.

According to the analysis, the study group showed no differences in the DIAGNOdent values in the studies 1, 2 and 3 regarding all teeth (p>0.05). In the control group, no differences were revealed for any of the dental groups, either (p>0.05). DIAGNOdent measurements do not statistically significantly differ in any of the studies (p>0.05).

Table 3. DIAGNOdent measurements regarding demineralization lesions no. 2 in a given patient (reduction/progression) in the study group and in the control group in 3 stages of the study.

Descriptive statistics	Study group			Control group		
	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3
N	32	31	31	29	29	29
M	29.31	25.61	26.32	33.10	29.79	27.69
Me	22.00	20.00	19.00	28.00	22.00	19.00
SD	20.92	19.12	21.61	21.70	22.46	20.62
Min	2.00	1.00	2.00	4.00	4.00	4.00
Max	97.00	88.00	99.00	99.00	99.00	99.00

N – number of subjects, M – mean, Me – median, SD – standard deviation, Min – minimum value, Max – maximum value

Demineralization lesion no. 3 in a given patient (reduction/lesion progression)

DIAGNOdent measurements regarding the third examined demineralization lesion in a given patient are shown in Table 4. In the study group, the mean value of DIAGNOdent measurements in the study 1 was 32.45±24.70, Me=24.00, in the study 2 the mean value was 29.39±22.52, Me=20.50, and in the study 3 it was around 26.93±21.76, Me=20.00. In the control group, the mean value of DIAGNOdent measurements in the study 1 was 28.82±16.77, Me=24.00, in the study 2 it was 26.36±17.22, Me=22.00, and in the study 3 it was 27.71±22.29, Me=20.00.

Table 4. DIAGNOdent measurements regarding demineralization lesions no. 3 in a given patient (reduction/progression) in the whole group of patients and in 3 stages of the study

Descriptive statistics	Study group			Control group		
	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3
N	29	28	28	28	28	28
M	32.45	29.39	26.93	28.82	26.36	27.71
Me	24.00	20.50	20.00	24.00	22.00	20.00
SD	24.70	22.50	21.76	16.77	17.22	22.29
Min	7.00	7.00	8.00	6.00	5.00	4.00
Max	99.00	99.00	99.00	77.00	80.00	99.00

N – number of subjects, M – mean, Me – median, SD – standard deviation, Min – minimum value, Max – maximum value

The study group showed no differences in the DIAGNOdent values in the studies 1, 2 and 3 regarding all teeth (p>0.05). In the control group, no differences were revealed for any of the dental groups, either (p>0.05).

Demineralization lesion no. 4 in a given patient (reduction/lesion progression)

DIAGNOdent measurements regarding the fourth examined demineralization lesion in a given patient are shown in Table 5. In the study group, the mean value of DIAGNOdent measurements in the study 1 was 29.72±19.48, Me=26.50, in the study 2 it was 30.78±26.39, Me=22.00, and in the study 3 it was 28.44±23.94, Me=19.00. In the control group, the mean value of DIAGNOdent measurements in the study 1 was 26.96±19.35, Me=21.50, in the study 2 it was 23.85±18.22, Me=20.00, and in the study 3 the recorded value was 22.27±17.98, Me=20.00.

Table 5. DIAGNOdent measurements regarding demineralization lesions no. 4 in a given patient (reduction/progression) in the whole group of patients and in 3 stages of the study

Descriptive statistics	Study group			Control group		
	Study 1	Study 2	Study 3	Study 1	Study 2	Study 3
N	18	18	18	26	26	26
M	29.72	30.78	28.44	26.96	23.85	22.27
Me	26.50	22.00	19.00	21.50	20.00	20.00
SD	19.48	26.39	23.94	19.35	18.22	17.98
Min	8.00	8.00	9.00	7.00	4.00	4.00
Max	78.00	99.00	99.00	96.00	99.00	99.00

N – number of subjects, M – mean, Me – median, SD – standard deviation, Min – minimum value, Max – maximum value

Comparison of DIAGNOdent measurements between studies 1-3

Comparing the first and the third study in the whole population of the study subjects, differences were shown in the demineralization lesion no. 1 (p=0.001*), demineralization lesion no. 2 (p=0.040*) and demineralization lesion no. 3 (p=0.027*).

As for demineralization lesion no. 1, as many as 41 subjects had a significantly lower DIAGNOdent score in the study 3, after 2 months of using the toothpaste, than in the preliminary study 1. As for demineralization lesion no. 2, the number of 33 subjects had a significantly lower DIAGNOdent measurement in the study 3 than in the study 1. As for demineralization lesion no. 3, as many as 36 subjects had a lower DIAGNOdent measurement in the study 3 than in the study 1. As for demineralization lesion no. 4, the number of 25 subjects had a lower DIAGNOdent measurement in the study 3 than in the study 1 (Table 6).

Table 6. Comparative analysis of the study 1 versus the study 3 regarding reduction or progression of demineralization lesion in the whole population of the study subjects

Study 1 – 3	Test value	Significance	Statistical analysis	
			Z	p
Demineralization 1	Negative ranks	41	-3.214	0.001*
	Positive ranks	18		
	Ties	2		
Demineralization 2	Negative ranks	33	-2.058	0.040*
	Positive ranks	22		
	Ties	5		
Demineralization 3	Negative ranks	36	-2.210	0.027*
	Positive ranks	17		
	Ties	3		
Demineralization 4	Negative ranks	25	-1.734	0.083
	Positive ranks	17		
	Ties	2		

Z – statistical analysis, test function value, U Mann-Whitney test, p – level of significance

Discussion

Available scientific publications do not provide information concerning studies of the effect of high-fluoride toothpastes on early carious lesions measured with the DIAGNOdent device. The present study provides reference to available articles on a similar topic.

Naidu *et al.* [7] conducted studies involving assessment of fluoric varnish, chlorhexidine varnish, and their combination on the remineralization of early lesions in the enamel of primary teeth. The number of 20 patients were studied and 80 lesions were isolated. They were divided into 4 groups. In the first group, fluoric varnish was used; in the second group, chlorhexidine varnish was used; and in the third group, the varnishes were used alternately. The procedure of varnish application was repeated 4 times every week, and then a follow-up examination was performed after 3 months. The highest efficacy of white spot remineralization was observed by these authors in group 3, where it reached 55%. In the group 1 it was 40%, while in the group 2, 30% reduction of initial white spots of demineralization lesions was recorded. In the study with the use of DIAGNOdent, the following results were achieved in particular groups: in the group 1, a change in the mean value from 9.25 to 7.3 was observed; in the group 2, a change from 8.9 to 5.15, and in the group 3, a change from 11.05 to 7.15. This study confirmed the best remineralization effect in the event of combined use of both varnishes. Moreover, the authors observed a higher remineralization potential of the fluoric varnish as compared with the chlorhexidine varnish.

In vitro studies conducted by Patil *et al*. [8] involved the assessment of the effect of 3 substances on the remineralization processes in the dental enamel. The first substance was a casein phosphopeptide-amorphous calcium phosphate complex, called in short CPP-ACP (GC Tooth Mousse); the second substance comprised the same complex combined with fluorine CPP-ACPF (GC Tooth Mousse plus); and the third substance was a tricalcium phosphate fluorine TCP-F (Clinpro Tooth crème). In the study, healthy (DIAGNOdent measurement in the range 3-7) molar and premolar teeth were used. Directly after extraction, they were placed in 10% formalin solution. Then, they were subjected to mechanical purification with the use of polishing devices. Each of the prepared sample was covered with nail varnish, excluding a 3 mm × 3 mm window, which was used as the study surface. The next stage involved placing the samples in a solution with pH 4.5 for 48 hours in an incubator at 37°C. After washing the samples with demineralized water and drying them, the samples with a DIAGNOdent score higher than 9 were qualified for the next stage of the studies. Each sample underwent 7 remineralization cycles with the use of the above-mentioned substance. This involved 4-minute rubbing of the active substance in the surface every 24 hours, and then storing the samples in the solution of artificial saliva. The studies of these authors proved the effect of using the three substances on the enamel remineralization. The highest efficacy was observed for products comprising TCP-F, where the remineralization efficacy was 54.24%, and the result of control with DIAGNOdent indicated a change in the result by 9.48±4.46. Lower efficacy was shown by the product comprising CPP-ACPF, where 34.42% remineralization efficacy was recorded after 7 days, and DIAGNOdent measurement was lower by 7.16±5.32. The lowest remineralization effect was shown by the product comprising only CPP-ACP, and the value of laser measurement was lower by 5.20±4.32. The study showed that the highest remineralization properties are achieved by combining the casein phosphopeptide-amorphous calcium phosphate complex and tricalcium phosphate with fluorine. It was also observed that full remineralization was not achieved within 7 days with the use of any of the studied substances.

In their studies, Llena *et al*. [9] compared the efficacy of fluoric varnish (Duraphat) with products containing the casein phosphopeptide-amorphous calcium phosphate complex CPP-ACP (MI Paste), also combined with fluorine CPP-ACPF (MI Paste Plus) in the treatment of early demineralization lesions in dental enamel. For the study, they qualified 786 lesions in the form of white spots on permanent teeth of children aged from 6 to 14 years old. Lesions within grooves and flat surfaces were qualified separately. They were examined with the use of the DIAGNOdent device, and the measurements were repeated after 4, 8 and 12 weeks. The authors revealed that all the agents showed efficacy regarding remineralization of early carious lesions. The products containing CPP-ACPF showed a higher remineralization potential of flat surface within the first 4 weeks of use in comparison with the fluoric varnish. All the other measurements showed superiority of the fluoric varnish.

In their *in vitro* studies, Leila B *et al*. [10] compared remineralization properties of 2 products containing the casein phosphopeptide-amorphous calcium phosphate

complex combined with fluorine CPP-ACPF – a very well-known toothpaste MI Paste Plus and a new product Reminpro. The study was conducted on healthy teeth extracted for orthodontic reasons. For 5 weeks, the samples were subjected to demineralization and remineralization cycles twice a day. After this time, they were examined with the use of the DIAGNOdent device, and it was shown that after use of MI Paste Plus, the reading of the laser meter was on average 23±5.60 and was lower than in the case of Remipro preparation. The authors showed a better effect on the product from GC on remineralization of early carious lesions, as well as a better effect of both preparations on the dental enamel of permanent teeth versus primary teeth.

In their studies, Liu *et al.* [11] examined the efficacy of using topical fluorides for 6 months in the form of varnish (5% NaF – Duraphat), silver diamine fluoride (SDF-Saforide) and sealants (Clinpro Sealant) in preventing decay in the grooves of permanent molar teeth. More than 500 children of school age were examined. The authors examined the occlusal tables with the use of DIAGNOdent and they qualified all the children with a score above 40 for the next stage of the study. A follow-up study was conducted after 2 years. They showed that all the agents had effective anti-decay activity.

Du *et al.* [12] studied 110 patients aged from 12 to 22 after orthodontic treatment with fixed braces who had demineralization lesions in the form of white spots. Duraphat varnish, containing 5% sodium fluoride (22 600 mg/L F-) was used in the study group every month for a period of six months. Before the study, measurements with DIAGNOdent were performed, which were repeated 3 and 6 months after using fluoric varnish. The mean initial DIAGNOdent measurement in the study group was 17.66±5.36, and in the control group 16.19±5.70. The first follow-up study after 3 months revealed a mean decrease in the result by 5.78, and for the control group, the DIAGNOdent measurement decreased by 2.44. After 6 months, another decrease in the mean result was observed in both groups, by 7.56 and by 3.09. The authors concluded that fluoric varnish had a positive effect on remineralization of early carious lesions and should be used as standard procedure after orthodontic treatment.

Perrini *et al.* [13] also studied the effect of fluoric varnish on early carious lesions after orthodontic treatment with fixed braces. The study subjects were divided into 2 groups with respect to the frequency of varnish application. In the group 1 it was used every 3 months (4×), and in the group 2 it was used every 6 months (2×). For each patient, the effect on 6 teeth was examined, and another 6 opposing teeth constituted a control group. Before the study initiation, and before each application of fluoric varnish, measurements with DIAGNOdent were performed. The authors showed differences in the demineralization degree between the teeth subjected and not subjected to fluorides, although they were not statistically significant. However, during the analysis of tooth localization, varnished front teeth showed a statistically significant decrease in demineralization, as compared with their unvarnished equivalents.

Among Polish researchers, a study of the effect of ozone therapy and local application of fluorides in the treatment of early decay was conducted by Stefański *et al.* [14], who studied 61 patients aged 8-28, in whom they selected 502 teeth meeting the

study criteria (fully erupted premolars and molars with cavities in the range of 0-3 in the ICDAS-II scale, and the DIAGNOdent measurement below 30). The teeth qualified for the study were randomized to 4 groups: group 1 – 1-minute application of ozone with a concentration of 420 ppm and covering of grooves with Duraphat varnish; group 2 – 4-minute application of ozone with a concentration of 525 pm and covering of grooves with Duraphat varnish; group 3 – covering of grooves only with Duraphat varnish; group 4 – control group. After 1, 3 and 6 months, the carious lesions were again assessed both visually and with the use of DIAGNOdent. The authors of this study showed that in all the study groups significant inhibition of initial carious lesions was observed, as compared with the control group. No significant differences were observed regarding a change in the ICDAS scores and DIAGNOdent readings between the study groups.

Johansson *et al*. [15] studied the effect of ozone and Duraphat fluoric varnish on early demineralization lesions covering occlusal tables of primary molar teeth. The number of 50 pairs of teeth were qualified for the study and were examined with the use of DIAGNOdent. Then, the first part involved administration of ozone at a concentration of 2,100 ppm for 40 s, and the second part involved administration of Duraphat varnish. The laser measurement and the application of ozone and varnish was repeated after 3, 6 and 9 months. After 12 months, final measurements were performed and compared with one another. The authors did not show inhibition of carious lesions within the lesions comprising enamel deficit. Regarding early carious lesions, they observed a slight progression or no progression. They concluded that the use of fluoric varnishes and ozone in the treatment of early carious lesions within occlusal tables of primary teeth may support inhibition of such lesions.

Conclusions

DIAGNOdent readings indicate a significantly more frequent remineralization effect of using a high-fluoride toothpaste as compared to toothpaste with standard fluoride content. The finding may be used in prophylactic and therapeutic activities in the first stage of demineralization lesions of tooth enamel.

References

1. Górska R. *Choroby błony śluzowej jamy ustnej*. Otwock: Med. Tour Press Intrnational Wyd. Medyczne; 2007. p. 23.
2. Fluorides and Oral Health. *Report of a WHO Expert Committee on Oral Health Status and Fluoride Use. WHO Technical Report Series No. 846*. Geneva 1994;37:1-19.
3. Kaczmarek U, Majewska L, Olczak-Kowalczyk D. Postawa i wiedza stomatologów w zakresie profilaktyki fluorkowej. *Nowa Stomatol*. 2015;20(1):23-8.
4. Ogaard B. CaF2 formation: cariostatic properties and factors of enhancing the effect. *Caries Res*. 2001;35(1):40-4.
5. Weyant RJ, Tracy SL, Anselmo TT, et al. American Dental Association Council on Scientific Affairs Expert Panel on Topical Fluoride Caries Preventive Agents: Topical fluoride for caries prevention: executive summary of the updated clinical

recommendations and supporting systematic review. *J Am Dent Assoc*. 2013;144(11): 1279-91.

6. Socha A, Gałęska M, Skomro P, Opalko K. Ocena zaawansowania choroby próchnicowej zębów stałych za pomocą urządzeń DIAGNOdent i DIAGNOdent Pen 2190. *Acta Bio-Optica et Infromatica Medica*. 2009;15(3):235-7.

7. Naidu S, Tandon S, Nayak R, et al. Efficacy of concomitant therapy with fluoride and chlorhexidine varnish on remineralization of incipient lesions in young children. *Int J Clin Pediatr Dent*. 2016; 9(4): 296-302.

8. Patil N, Choudhari S, Kulkarni S, Joshi SR. Comparative evaluation of remineralizing potential of three agents on artificially demineralized human enamel: An in vitro study. *J Conserv Dent*. 2013;16(2):116-20.

9. Llena C, Leyda AM, Forner L. CPP-ACP and CPP-ACFP versus fluoride varnish in remineralisation of early caries lesions. A prospective study. *Eur J Paediatr Dent*. 2015;16(3):181-6.

10. Leila B, Nemati S, Neda H, Khanehmasjedi M. The effect of MI paste Plus and Reminpro on incipient caries using DIAGNOdent and SEM: an in vitro study. *J Natl Med Assoc*. 2017;109(3):192-7.

11. Liu BY, Lo EC, Chu CH, Lin HC. Randomized trial on fluorides and sealants for fissure caries prevention. *J Dent Res*. 2012;91(8):753-8.

12. Du M, Cheng N, Tai B, et al. Randomized controlled trial on fluoride varnish application for treatment of white spot lesion after fixed orthodontic treatment. *Clin Oral Invest*. 2012;16:463-8.

13. Perrini F, Lombardo L, Arreghini A, et al. Caries prevention during orthodontic treatment: In-vivo assessment of high-fluoride varnish to prevent white spot lesions. *Am J Orthod Dentofacial Orthop*. 2016;149(2):238-43.

14. Stefański T, Słota A, Siedlok M, et al. Ozonoterapia i miejscowe stosowanie fluorków w leczeniu próchnicy początkowej bruzd w zębach stałych – 6-miesięczne badania kliniczne. *Dent Med Probl*. 2012;49(2):237-46.

15. Johansson E, van Dijken JW, Karlsson L, Andersson-Wenckert I. Treatment effect of ozone and fluoride varnish application on occlusal caries in primary molars: a 12-month study. *Clin Oral Investig*. 2014;18(7):1785-92.

Corresponding author
Elżbieta Pels
Department of Developmental Age Stomatology
Medical University of Lublin
Karmelicka St. 7, 20-081 Lublin
e-mail: elzbieta.pels@umlub.pl