

In Vitro Study of the Effects of Fluoride-Releasing Dental Materials on Re-Mineralization of Deciduous Teeth

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Abstract

Purpose: This study has been conducted to compare the re-mineralization effects of five regimens of fluoride varnishes and pastes on the loss of fluorescence intensity, in vitro model- deciduous teeth.

Methods: Forty deciduous intact teeth enamel surfaces were etched for 60 sec. Teeth surfaces were prepared into the five following groups which were treated with dental materials: (1) Fluor Protector (FP), (2) Clinpro White Varnish (CV), (3) Gum paste 500 ppm F, (4) Gum paste 1000 ppm, (5) Tooth Mousse (TM). Only CV is intended to be applied on dentin surfaces. They were investigated using DIAGNOdent Pen to measure the values of laser fluorescence of intact enamel surfaces.

Results: Results in enamel structure were decreased with two degrees in the all models. Results in dentin structure after application with CV were decreased with 1.30 degree. We have not established any significant variations of the values after application of CV, TM and GUM paste 1000 ppm on intact enamel surfaces.

Conclusions: Clinpro white varnish (CV) dental materials can promote greater effect of re-mineralization of the artificially provoked enamel lesions than can F-based dental materials do.

Keywords: DIAGNOdent Pen, demineralization, re-mineralization, laser fluorescence, deciduous teeth.

I. Introduction

The enamel non-cavitated lesions of human teeth can be caused by caries, tooth wear and congenital dental anomalies, all of them resulting on the irreversible loss of dental hard tissues [1-3]. The primary mineral in enamel is hydroxyapatite, which is a crystalline calcium phosphate into calcium phosphate and hydroxyl ions [4,5]. The usefulness of fluoride-releasing materials for enamel re-mineralization has been demonstrated in various models, using different methods [6,7,10,11]. Enamel re-mineralization has been studied for approximately 100 years, during which time many successful re-mineralizing agents have been made available [8,9,12]. The re-mineralization efficiency of fluoride-releasing dental materials is related to the fluoride content, fluoride matrices, setting mechanisms and other material components [13,14,15,16]. Contemporary approaches to the treatment of enamel lesions are based on the idea of “demineralization and re-mineralization” in a micro-phase to retain healthy teeth [17].

II. Materials and methods

This study included all groups of 40 deciduous teeth. All used teeth are deciduous and have fallen by physiological change break-through from permanent. All teeth have complete root resorption, all teeth are with open pulp chamber-senile period of deciduous teeth. The teeth were cleaned to remove all soft and hard tissues prior to testing. DIAGNOdent Pen with a probe for occlusive pit-and-fissure tooth decay and smooth surface was used.

The study was performed in the following sequence:

1. DIAGNOdent pen was calibrated with intact enamel surface standard before starting the measurements and after testing.
2. The values on intact enamel and dentin surfaces were measured.
3. The samples were treated with 37% H₂PO₃ etchant, in order to induce a stimulated process of demineralization, as follows:
 - a. 40 enamel surfaces were etched for 60 sec.
 - b. Teeth were rinsed, dried and measured again with DIAGNOdent Pen.
4. Re-mineralization

Forty teeth surfaces were prepared and divided into five groups, which were treated with the following dental materials: (1) Fluor Protector (FP) with 0,1% concentration of fluoride components, (2) Clinpro White Varnish (CV) Tri-Calcium Phosphate containing 22,6mg F, (3) Gum kids paste with 500ppm F, (4) Gum paste with 1000ppm, (5) Tooth Mousse (CPP-ACP cannot compare with that of fluoride agents). The enamel of the

three windows was re-mineralized (1,2,3,4,5- dental materials) for 1 hours, at 37° C – air temperature in the stacked plastic bags.

Only Clinpro White Varnish is intended to be applied on dentin surfaces and used as a cement-based filling material, since only it is recommended for this purpose. After the procedure of re-mineralization, the specimens of each group were divided into five groups and tested by the method applying DIAGNOdent Pen.

II. Results

The results obtained from the study are presented on Tables 1 and 2.

After application of Clinpro White Varnish on the enamel surfaces for one hours an average decrease of 6,15 (\pm 2,03) was detected. After application of Fluor Protector on the enamel surfaces for one hours an average decrease of 6,37 (\pm 3,05) of the indicator of fluorescence intensity was detected. After applications of GUM paste with F concentration of 500 ppm and 1000 ppm upon the enamel surfaces for one hours an average decrease of 5,85 (\pm 2,27) and 4,83 (\pm 1,46) , respectively, was detected. The detected average values of decrease of laser fluorescence of the enamel were 4,37 (\pm 1,35) - for GUM paste with 500 ppm F and 4,67 (\pm 1,54) for GUM paste with 1000 ppm F, respectively.

Results in enamel structure were decreased with two degrees in the models with all dental materials after demineralization, an average increase 9,40 (\pm 3,27) and after re-mineralization- an average decrease of 5,58 (\pm 2,04). Average decrease for FP and GUM paste 500 ppm were 6,37 (\pm 3,05) and 5,85 (\pm 2,27) in comparison an average value for intact enamel surfaces 3,85 (\pm 1,29) and 4,37 (\pm 1,35) . We did not observe any significant variations of the values after application of CV, TM and GUM paste 1000 ppm on enamel surfaces.

The results of the comparative analysis of the therapeutic effectiveness of used dental varnishes - Fluorine Protector and Clinpro White Varnish showed a significant difference in the percentage of efficiency ($t = - 3,68$, $p < 0.001$), as Clinpro White Varnish shows better results after application (64,58%) (Table 1). The study of the accompanying GUM toothpastes also showed a significant difference in performance ($t = 2,60$, $p = 0.011$), as GUM kids paste - 500 ppm showed better results (67,89%) compared with the paste GUM - 1000 ppm (58,72%) (Table 1).

Research and pastes showed a significant difference in terms of reduction of avtofluorestsentsiyata after application ($t = 2,39$, $p = 0.02$), as GUM kids pasta - 1000 ppm indicated better results 4.83 to 5.85, for GUM paste - 500 ppm (Table 1). Analysis of therapeutic effectiveness in all the dental means shows that the results obtained after application of Tooth Mousse superior to those of the other vehicles ($F = 9,49$, $p < 0.001$). Clinpro White Varnish is third in effectiveness after Tooth Mousse and GUM kids pasta - 500 ppm. (Table 1).

The results in Table 2 show that univariate regression analysis achieves higher values of the coefficient in the lacquer Fluor protector ($\beta = 0,598$) with respect to the study of the relationship between the effectiveness and the reduction of fluorescence, this dental varnish influences 34, 10% of the changes achieved in therapeutic efficacy, and the lowest dependence was observed in Clinpro White Varnish ($\beta = 0,332$), which affects only 8.70% of variations in performance.

III. Discussion

The enamel in vitro lesions values for d1 – 7 to 12. Clinpro white varnish (CV) dental materials can promote greater effect of re-mineralization of the artificially provoked enamel lesions than can F- based dental materials do. Our results showed that CV was more effective than FP in the process of re-mineralization of teeth surfaces. Moreover, CV also contains calcium and phosphate ingredients, which are necessary and serve as useful supplements in the process of re-mineralization. Based on the results of the four methods of investigation, we found that TM did not have significant properties of re-mineralizing effect, compared with the fluoride-releasing dental materials. The loss of fluorescence intensity of FP, CV, GUM paste 500 ppm, GUM paste 1000ppm group showed significant reduction after the procedure of re-mineralization. We hope that these results can serve as scientifically-established prerequisite for the clinical application of these materials.

IV. Conclusions

1. According to this in vitro conducted study may be concluded that changes in the degree of re-mineralization of deciduous teeth structures can be detected by using DIAGNOdent Pen.
2. The procedure of enamel etching for 60 sec. provides conditions for comparison of variations of the degree of laser fluorescence.
3. The obtained values after 60 sec. of etching revealed an almost double increase compared with the average value for intact enamel surfaces.
4. The obtained values after a time interval of one hours of applications revealed an almost double decrease of fluorescence intensity compared to the procedure of etching for 60 sec. of the enamel layer.

5. Clinpro white varnish (CV) dental materials can promote greater effect of re-mineralization of the artificially provoked enamel lesions than can F-based dental materials do.

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Table 1. Changes in laser fluorescent measurements detected for enamel after applicaton with dental materials

Dental materials	Fluor Protector	Clinpro White Varnish	GUM kids paste-500ppm	GUM kids-paste 1000ppm	Tooth Mousse
Performance					
Number of surfaces	40	40	40	40	40
An average value for Intact Enamel surfaces	3,85 ± 1,29	4,43 ± 1,01	4,37 ± 1,35	4,67 ± 1,54	4,03 ± 1,31
Number of Surf. With Decreased values	0/ 0,0 %	0/ 0,0 %	0/ 0,0 %	0/ 0,0 %	2/ 5,0%
An average Increase Etching time-60 sec.	13,00 ± 4,71	10,00 ± 3,94	8,57 ± 2,48	8,47 ± 2,67	6,97 ± 2,53
An average Decrease	6,37 ± 3,05	6,15 ± 2,03	5,85 ± 2,27	4,83 ± 1,46	4,72 ± 1,39 (за 10 мин)
Efficiency in %	50,45 ± 17,60	64,58 ± 16,71	67,89 ± 15,26	58,72 ± 16,29	70,36 ± 15,94

Tabl. 2. Correlation between the effectiveness and the decrease in fluorescence at different types of dental tools

Dental medications	Nonstandard Factor \square	Standard Factor \square	p	Adjusted R ²
Fluor Protector	0,104	0,598	<0,001	0,341
Clinpro White Varnish	0,040	0,332	0,036	0,087
GUM kids paste-500ppm	0,089	0,601	<0,001	0,344
GUM kids paste-1000ppm	0,039	0,436	0,005	0,168
Tooth Mousse	4,342	0,380	0,016	0,122