Evaluation of the effects of dental varnishes on the oral health

Ph.D. thesis

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1. Introduction

The preventive approach is gaining increasing significance in today's medical science, including the field of stomatology. Dentists perform their work on different levels of prevention. This activity ideally means the prevention of the development of dental problems but in Hungary, what we do in most cases today is that we stop the progress of the disease, or perform oral cavity rehabilitation, especially in the case of adults. The efficiency of a care system, however, should be measured on the level of oral health rather than by the number of documented cases and oral cavity rehabilitations.

The majority of oral cavity problems that occur in children and adolescents is caused by caries and its consequential diseases, the factors contributing to the development of which and its influencing factors have been examined by a high number of epidemiologic research projects both in Hungary and abroad. According to a report issued by the World Health Organization (WHO) in 2003, dental caries continues to be a significant public health issue, which affects 60-90% of school-age children and the majority of adults in most industrialized countries. In Europe, this problem is significant mainly in the Eastern countries. In countries with a developed health culture, one can witness a considerable decrease in the prevalence of caries due to the activities performed in the context of primary prevention. In the case of those patients or groups of patients where the chances for the development of caries are increasing, we talk of a high risk of caries. The application of different preventive methods is strongly recommended for high caries risk patients.

In some cases, the risk of caries may rise temporarily as well. Thus, for example, those patients who use fixed orthodontic appliance belong to the high caries risk group during the period of orthodontic treatment. In the case of these patients, plaque retention is of a higher extent and it is more difficult to maintain appropriate oral hygiene, typically around the parts of the fixed orthodontic appliance, between the brackets/tubes and the marginal gingiva. Those patients who have recently emerged permanent molar teeth also belong to the group of patients who are temporarily at a high risk for the development of caries. This means that in the case of the first permanent molar teeth, it is the age group between 5 and 7 years that is at risk, while in the case of the second permanent molar teeth, the age group between 11 and 14 years is jeopardized. In the fissures of recently emerged permanent molar teeth, we can find a thinner and less mineralized layer of tooth enamel, so the occlusal surface of these teeth is especially susceptible to the development of caries and the process very quickly reaches the dentin. For efficient prevention, it is critical to consider the prevalence of these conditions and the extent of the risk, as well as to be aware of the preventive procedures and the effectiveness thereof.

Fluoride varnishes were developed in the late 1960's with the intention of increasing the duration while fluoride is in direct contact with the surface of the teeth and thus, the fluoride uptake is continuously ensured as well. Since 2004, these varnishes have become more and more commonly applied substances in the US and Europe, although they are less frequently applied in Hungary. The great advantage of fluoride varnishes as compared to the other local fluoride application opportunities is that they

can be easily incorporated into preventive public health programs, they are easy to use and they are safe to apply, furthermore, they have prolonged fluoride release time. In preserving the oral cavity health of the patients, in addition to the regular checkups, appropriate instructions, motivation, the application of fluorides, the use of chlorhexidine formulas may also prove to be efficient. A wide range of formulas with chlorhexidine content is available, including, among others, professionally applicable dental varnishes.

2. Objectives

The fundamental objective of our research is to examine the effect of dental varnishes on oral health and to elaborate the strategies that can be applied in practice for patients with a high risk of caries.

2.1. Examination of the effect of chlorhexidine-thymol dental varnishes in the case of patients using fixed orthodontic appliance

2.1.1. Examination of the effect of chlorhexidine-thymol (CHX-T) dental varnishes on the colonization of Streptococcus mutants and Lactobacilli.

2.1.2. Examination of the effect of chlorhexidine-thymol dental varnishes on the development of early caries lesions (white spots).

2.2. Comparative examination of chlorhexidine and fluoride dental varnishes in the occlusal fissures of young permanent molar teeth

2.2.1. Comparative examination of the effect of chlorhexidine-fluoride (CHX-F) and chlorhexidine-thymol (CHX-T) dental varnishes on the colonization of Streptococcus mutants.

2.2.2. Comparative examination of the effect of chlorhexidine-fluoride and chlorhexidine-thymol dental varnishes on the development of early caries lesions (white spots).

3. Patients and methods

3.1. Examination of the effect of chlorhexidine-thymol dental varnishes in the case of patients using fixed orthodontic appliance

In our survey, 32 patients (14 boys and 18 girls) were involved, who received fixed orthodontic treatment at the Department of Paediatric Dentistry and Orthodontics of Semmelweis University. There were three participants who did not continue the examinations from the second occasion without any explanation. Finally, a total of 29 patients between 13 and 20 years of age took part in the entire examination [average age 16.5 ± 2.75 years (average ± S.D.)]. We involved such patients in the research project who did not suffer from any general conditions or periodontal diseases, who did not smoke and did not receive antibiotic treatment in the four months preceding the examination and during the examination. The use of fixed and removable dentures, as well as the existence of

an active caries lesion were also reasons for exclusion from the examination. Those patients in the case of whom the value of Streptococcus mutants (SM) at the time of the baseline test was 0 were also excluded from the project. It was a criterion for participation that at least 20 permanent teeth had to be involved in the treatment with fixed orthodontic appliance. The average DMF-S index value of the patients involved in the examination was 1.4 ± 1.5 (average ± S.D.). This value essentially meant the number of filled tooth surfaces, as we did not involve any such patients in our examination in whose case we detected untreated caries, and where a tooth was extracted as a consequence of caries. The average DMF-T index value was 0.8 ± 0.75 (average ± S.D.). Based on the two-sample t-tests, there was no significant difference between the patients with regard to caries prevalence.

The research was conducted in possession of the authorization (TUKEB No.: 209/2011) issued by the Regional, Institutional Scientific and Research Ethics Committee of Semmelweis University. The patients (in the case of children under the age of 18, the parents or the guardians) were given oral and written information on the project, its objectives, the procedure, and they gave their informed consent.

Prior to the commencement of the examinations and the treatments, the patients were given oral and written information on the oral hygiene activities that were recommended for the treatment period: brushing their teeth twice a day (in the morning and in the evening) with toothpaste with fluoride content of 1450 ppm (Colgate Total® Original), by applying the modified Bass

technique, with a traditional, medium hard toothbrush (Oral B Pro Expert toothbrush). For the cleaning of the vestibular surface of the teeth, a special orthodontic toothbrush (Oral B Ortho toothbrush) was also used. The application of no other oral hygiene formulas or appliances (such as mouthwash or dental floss, etc.) was allowed during the time of the project. One day before the taking of the samples, the patients were not allowed to perform any oral hygiene activities and they were not allowed to eat for two hours before the samples were taken. Each of the patients taking part in the project was right-handed. The toothbrushes were provided to the participating patients by the company Procter and Gamble Oral B (Cincinnati, USA), while the toothpastes were ensured by Colgate-Palmolive (New York, USA).

During the baseline test (before the fixed orthodontic appliance were secured), we defined the levels of the two groups of acid-producing cariogenic bacteria (Streptococcus mutant – SM, Lactobacillus – LB) in the saliva by relying on chairside tests (CRT Bacteria, Ivoclar-Vivadent, Schaan, Liechtenstein). We recorded the dental status of each patient, specifically indicating white spot lesions (WSL).

After the baseline test, we professionally cleaned the teeth with a fluoride-free polishing paste (Proxyt®, Ivoclar-Vivadent, Schaan, Liechtenstein) and a polishing brush, then we secured the fixed orthodontic appliance (Unitek™ Gemini bracket and Victory Series™ Superior Fit Buccal tube, 3M Unitek Orthodontic) to the vestibular surface of the upper teeth (at a more than 1.5 mm distance from the marginal gingiva) by using a composite adhesive system

(Transbond XT® 3M Unitek, Neuss, Germany), according to the manufacturer's instructions. Then we treated each patient with the test and placebo varnishes. The test varnish was the one called Cervitec® Plus (Ivoclar - Vivadent, Schaan, Liechtenstein), which has a chlorhexidine content of 1% and a thymol content of 1%, while the placebo varnish (Ivoclar-Vivadent, Schaan, Liechtenstein) did not contain any antibacterial components but regarding its other components, it was the same as the test varnish. We applied the test and placebo varnishes randomly in the right and left quadrants of the upper dental arch, on the vestibular surface of the teeth. The random distribution of the quadrants in the test and control groups was determined by using a "random number generator" program (via an online platform: www.random.org), then this was recorded along with the patient codes in the medical records of the patients involved in the examination. This signal was not indicated in the coded data sheets used for the recording of the examination results. The varnishes Cervitec® Plus and Placebo were applied on the upper middle incisors, the upper canine teeth, the upper second premolar teeth and the upper first molar teeth around the brackets and tubes, according to the manufacturer's instructions. After the application of the varnishes, the patients were not allowed to eat or drink for one hour and they were not permitted to perform any oral hygiene activities either (they could not brush their teeth). The varnishes called Cervitec® Plus and Placebo, the CRT Bacteria microbiological tests and incubators were provided for the examinations by the company Ivoclar-Vivadent (Schaan, Liechtenstein).

During the six-monthly period of the survey, we repeated the cleaning of the teeth, the application of the varnishes, the oral hygiene instructions and motivation on a monthly basis. Before the application of the varnishes, we took a sample from the dental plaque on the brackets on the upper middle incisors, the upper canine teeth, the upper second premolar teeth, as well as the dental plaque around the tubes stuck on the upper first molar teeth on each occasion. We determined the levels of Streptococcus mutant and Lactobacilli in the saliva and that of Streptococcus mutant in the plaque samples by applying the chairside tests that we also used during the baseline test. In line with the instructions of the manufacturer, we grouped the plaque samples in two categories based on the number of bacteria: there was a low risk (number of bacteria $<10^5$ CFU/ml) and a high-risk group (number of bacteria $\geq 10^5$ CFU/ml).

3.1.1. Statistical analysis

For the statistical analysis, we applied the Wilcoxon test and the descriptive statistical methods by relying on a computer program (SPSS-Statistical Package for Social Sciences for Windows, version 18.0; Chicago, USA). We defined the significance level at 0.01 ($p<0.01$). We assessed the level of Streptococcus mutant in the plaque by using an additive index (SM index). We determined the SM level of the plaque for four teeth by each quadrant (upper middle incisor, upper canine tooth, upper second premolar tooth, upper first molar tooth) in each patient, and it was by adding these values that we arrived at the index value (minimum value: 0, maximum value: 16). It was by applying multivariate linear regression that we assessed the changes occurring in the SM and LB levels of the saliva during the study. We used the same method for the

evaluation of the new WSL number arrived at the end of the examination.

3.2. Comparative examination of chlorhexidine and fluoride dental varnishes in the occlusal fissures of young permanent molar teeth

A total of 57 healthy persons of the age between 7 and 14 years took part in our examinations [average age: 9.1±1.9 years (average ± S.D.)]. As regards the proportion of the sexes, 59% of the participants were girls, while 41% were boys. The participants, on the one hand, became part of the project from the Swedish Halland Hospital (n=31), on the other hand, from the Department of Paediatric Dentistry and Orthodontics of Semmelweis University (n=26) from school dental screening examinations. Prior to the commencement of the study, the participants and their parents were provided oral and written information and they gave their informed consent. The fundamental criterion of participation in the project was the existence of one or both permanent molar teeth in one or both dental arches without any sign of clinical caries (ICDAS 0-2). Those who suffered from chronic diseases, or those who received antibiotic treatment in the six weeks preceding the baseline test or during the examination could not participate in our examinations. A further reason for exclusion was the application of a formula containing another fluoride or another antiseptic in addition to that in the toothpaste. At the place of residence of the participants, the natural fluoride content of drinking water was low (<0.3 ppm). The patients cleaned their teeth twice a day (in the morning and in the evening) with toothpaste of a fluoride content of 1100-1450 ppm, by applying the

modified Bass technique. We involved a total of 87 homolog pairs of first and second permanent molar teeth in the study. Three children dropped out of the study, this is why we assessed the final results for 54 patients, 73 pairs of first permanent molar teeth and 8 pairs of second permanent molar teeth.

The occlusal fissures of molar teeth were treated with a varnish containing 0.34% chlorhexidine and 1400 ppm of ammonium-fluoride on the test sides (CHX-F; Cervitec® F, Ivoclar-Vivadent, Schaan, Liechtenstein), while the fissures of the control teeth on the opposite side were treated with a Cervitec® Plus varnish containing 1% chlorhexidine and 1% thymol (CHX-T, Ivoclar-Vivadent, Schaan, Liechtenstein). Our null hypothesis was that the varnish with CHX-F content was at least as efficient as the CHX-T varnish without any fluoride content with regard to the parameters under review.

In the case of the patients involved in the study, we examined and classified the teeth by the ICDAS II criteria after having performed professional cleaning with fluoride free polishing paste (Proxyt®, Ivoclar-Vivadent, Schaan, Liechtenstein) and a polishing brush, as well as drying with a dental puster. It was the molar tooth pairs with values of 0, 1 and 2 according to the ICDAS II classification that were involved in the project. We determined the random distribution of the teeth in the test group and the control group (right-/left-hand side) by relying on the “random number generator” program (via an online platform: www.random.org). In case that several molar tooth pairs were involved in the project in the case

of a patient, we applied the same type of varnish on the teeth on the same side.

After having dried the surface of the teeth with compressed air, according to the manufacturer's instructions, we applied the varnishes to the occlusal surface of the teeth in a thin layer by using a microbrush, then we left it to dry for one minute. We used one single drop of varnish (appr. 0.10 grams) for each tooth. After the drying, we firmly asked the patients to refrain from eating and drinking for one more hour. Then we repeated the application of the varnishes every six weeks during the examination period. Both types of varnish were made available to us by the company Ivoclar-Vivadent in single-dose packaging. The doctors applying the varnishes and the patients were not aware of what the content of the crucibles was and the person doing the microbiological evaluation was not aware of which type of varnish had been applied on which side teeth of the patient in question.

During the six-monthly survey, at the time of the baseline test, then every six weeks, we took a plaque sample from the occlusal fissures of the teeth involved in the project in order to determine the SM level. The plaque samples were taken by using a microbrush after the careful drying of the fissures with compressed air, then the samples were immediately put on a selective medium (dip-slide agar, CRT bacteria, Ivoclar-Vivadent, Schaan, Liechtenstein). We incubated the inoculated samples at 37°C for 48 hours (in a micro-aerophile $NaHCO_3$ environment). Then we morphologically identified the colony forming units, i.e. CFU's by using a stereomicroscope, magnified 10-20 times and we assessed them on the basis of the evaluation

sheet attached by the manufacturer. Based on the number of bacteria, we classified the samples in the following 5 groups: 0 = no colony forming; 1 = 10^3 CFU/ml; 2 = 10^4 CFU/ml; 3 = 10^5 CFU/ml; and 4 = 10^6 CFU/ml.

The laser fluorescence (LF) tests for detecting caries were performed by the DIAGNOdent pen device (KaVo, Biberach, Germany) at the time of the baseline test, then we repeated this every 12 weeks. As regards the laser fluorescence values, at the time of the baseline test, there was no significant difference between the two groups. We used the same instrument with the same tip during the entire period of the study. After calibration, we performed the measurements on the tooth surfaces dried with air. We placed the tip of the device in the central occlusal fissure in a slightly tilted position. The LF measurements before the application of the varnishes were performed by a researcher for each patient at both sites of the examination.

Our double-blinded split-mouth study was permitted by the Regional Ethical Review Board in Lund, Sweden (Dnr: 2014/262), as well as the Regional, Institutional Scientific and Research Ethics Committee of Semmelweis University in Hungary (TUKEB No.: 193/2014).

3.2.1. Statistical analysis

During the statistical analysis, the data were processed by using the IMB - SPSS software (version: 23.0, Chicago, USA). In the case of those patients where more than one tooth pair was involved in the project, we calculated average values both with regard to the number of bacteria and the LF values, so we could consider the patients as statistical units. We compared the bacterial values received after the application of the two types of varnish by applying the chi-square test, while the intra-group

comparison was performed by using the McNemar test. For this purpose, we grouped the values in low risk (values from 0 to 2) and high risk (values from 3 to 4) categories. We performed the comparison of the laser fluorescence values of the two groups by using the Wilcoxon test. In the case of the repeated measurements, the values of the tests were compared to the initial values by using a two-factor variance analysis, with a 5% significance level ($p < 0.05$).

4. Results

4.1. Examination of the effect of chlorhexidine-thymol dental varnishes in the case of patients using fixed orthodontic appliance

As regards microbiological results, we experienced significant decrease in the *Streptococcus mutant* values of the *dental plaque* during the six-monthly examination period in the test quadrants [SM index: from 11.17 ± 1.93 to 4.48 ± 0.78 (average ± S.D.)] treated with a varnish containing chlorhexidine-thymol as compared to the values of the control quadrants [SM index: from 12.69 ± 2.29 to 8.24 ± 2.84 (average ± S.D.)] treated with a placebo varnish ($p<0.01$).

As regards the changes in the level of the *Streptococcus mutant of saliva*, we experienced that the number of low risk saliva samples ($<10^5$ CFU/ml SM) was significantly higher from the second month (2nd-3rd month: 75,9 %; 4th month: 89,7 %; 5th month: 93,1 %; 6th month: 96.6 %) than the values measured at the time of the baseline test (51,7 %) ($p<0.01$).

As regards the changes in the level of *Lactobacilli in saliva*, the number of low risk saliva samples ($<10^5$

CFU/ml LB) was significantly higher from the second month (2nd-4th month: 68,9 %; 5th month: 75,9%, 6th month: 86,2 %) of the examination than the values measured at the time of the baseline test (51,7 %) ($p<0.01$).

Our findings related to *white spot lesions* showed that by the end of the examination period, the number of newly developed white spot lesions was significantly lower on the test side treated with the varnish called Cervitec® Plus (0.07±1.60) (average ± S.D.) than that of the control side treated with a placebo varnish (1.14 ± 1.50) (average ± S.D.) ($p<0.01$).

4.2. Comparative examination of chlorhexidine and fluoride dental varnishes in the occlusal fissures of young permanent molar teeth

At the time of the baseline test, 54% of the plaque samples taken from the fissures showed a high ($\geq 10^5$ CFU/ml) SM value, then we experienced gradual reduction on both sides. After 18 weeks, less than 10% of the plaque samples taken from the fissures showed high Streptococcus mutant values. The number of plaque samples showing a high SM value was the lowest at the end of the study, i.e. after 24 weeks: in the CHX-F group, it was 2% of the plaque samples taken from the fissures, while in the CHX-T group, it was 4% of the plaque samples taken from the fissures that showed high SM values. The varnish that also contains fluoride reduced the number of SM to a greater extent, we found no statistically significant difference between the two types of varnish during the six-monthly examination period.

As regards the laser fluorescence values, we experienced a statistically significant decrease in the CHX-F group already after 12, then 24 weeks, while we found the same in the CHX-T group only after 24 weeks ($p<0.05$). When we compared the two types of varnish, we found that the varnish of CHX-F content decreased the LF values (i.e. the value of the demineralization of the enamel) to a greater extent than the varnish of CHX-T content, we found no statistically significant difference between the two types of varnish during the examination period, only the tendency for this was visible.

5. Conclusions

5.1. Examination of the effect of chlorhexidine-thymol dental varnishes in the case of patients using fixed orthodontic appliance

- The application of dental varnishes with chlorhexidine content decreases the level of Streptococcus mutant in the saliva and the plaque.

- The application of dental varnishes with chlorhexidine content decreases the level of Lactobacilli in the saliva.

- The application of dental varnishes with chlorhexidine content decreases the development of new caries lesions.

- The application of dental varnishes with chlorhexidine content is an efficient preventive method in the case of patients with a high risk of caries.

5.2. Comparative examination of chlorhexidine and fluoride dental varnishes in the occlusal fissures of young permanent molar teeth

- The effects of dental varnishes containing chlorhexidine-fluoride and those with a chlorhexidine-thymol content are similar but the varnish containing chlorhexidine-fluoride reduces the colonization of Streptococcus mutant to a greater extent during the six-monthly examination.

- Based on the results of the laser fluorescence test, the varnish containing chlorhexidine-fluoride reduces the development of early caries lesions to a greater extent than the varnish containing chlorhexidine-thymol, during a six-monthly examination period, no significant difference could be seen between the effects of the two types of varnish under review. The beneficial effects of fluorides could be experienced when the varnish of CHX-F content was applied, as well as the antibacterial effects of CHX could be seen without any decrease in the efficiency of the two formulas, what is more, these effects added up. In a longer-term application, this effect will probably be detectable statistically as well but the tendency was visible in our examination too.

- The application of varnishes containing chlorhexidine-fluoride may be an alternative to the fissure sealant in the occlusal fissures of the high caries risk young permanent molar teeth.

5.3. New scientific findings

1. The monthly application of a dental varnish containing chlorhexidine decreases the levels of Streptococcus mutant in both the saliva and in the dental plaque, in the case of high caries risk patients using fixed orthodontic appliance.

2. The monthly application of a dental varnish containing chlorhexidine decreases the level of Lactobacilli in the saliva, in the case of high caries risk patients using fixed orthodontic appliance.

3. The monthly application of a dental varnish containing chlorhexidine decreases the chances of the development of incipient caries in the case of high caries risk patients using fixed orthodontic appliance.

4. The six-weekly application of a dental varnish containing chlorhexidine and fluoride decreases the level of Streptococcus mutant in the dental plaque in the occlusal fissures of young permanent molar teeth of high caries risk.

5. In the case of the six-weekly application of a dental varnish containing chlorhexidine and fluoride, a lower chlorhexidine concentration is also sufficient for the significant reduction of the level of biofilm Streptococcus mutant than in the case of the application of a varnish that only contains chlorhexidine in the occlusal fissures of young permanent molar teeth of high caries risk.

6. The six-weekly application of a dental varnish containing chlorhexidine and fluoride decreases the chances for the demineralization of enamel, as well as the

development of incipient caries in the occlusal fissures of young permanent molar teeth of high caries risk, which have recently emerged.

6. List of own publications

Publications related to the dissertation

Lipták L, Bársony N, Twetman S, Madléna M. (2016) The effect of a chlorhexidine-fluoride varnish on mutans streptococci counts and laser fluorescence readings in occlusal fissures of permanent teeth - a split-mouth study. Quintessence Int, 47:767-773.

IF: 0,995

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IF: 2,188

Madléna M, **Lipták L.** (2014) Prevention of dental caries with fluorides in Hungary. Paediatrics Today, 10:84-94.

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Lipták L, Káldy A, Bársony N, Szabó K, Márton S, Nagy G, Madléna M. (2015) Effects of chlorhexidine containing varnish on oral and dental health in high risk patients. Caries Res, 49:300-300. Abstract number: 6.

Lipták L, Bársony N, Twetman S, Madléna M. (2016) Effects of chlorhexidine-fluoride varnishes in occlusal fissures of permanent molars. Community Dent Health, 33: 24-25. Abstract number: 3315.

Presentations related to the dissertation

Madléna M, **Lipták L**. Fluoride prevention in Hungarian children and adolescents. XIII.th Oral health and Dental Managment Congress in the Central and Eastern European Countries. Constanta, Romania

Lipták L, Káldy A, Bársony N, Szabó K, Márton S, Nagy G, Madléna M. Effects of chlorhexidine containing varnish on oral and dental health in high risk patients. PHD Scientific Days, Semmelweis University, Budapest, April 9-10, 2015.– **II. helyezett**

Lipták L, Káldy A, Bársony N, Szabó K, Márton S, Nagy G, Madléna M. Effects of chlorhexidine containing varnish on oral and dental health in high risk patients. 62nd Congress of the European Organisation for Caries Research, Brussels, Belgium, July 1-4, 2015. **- ORCA Conference Travel Fellowship**

Lipták L, Bársony N, Madléna M. Effect of a chlorhexidine/fluoride varnish on mutans streptococci colonisation and laser fluorescence readings in occlusal fissures of permanent molars. A split-mouth study. PHD Scientific Days Semmelweis University, Budapest, April 7-8, 2016.

Lipták L, Bársony N, Madléna M. Streptococcus mutans kolonizáció és a remineralizáció vizsgálata chlorhexidin/ fluorid tartalmú lakkok alkalmazását követően maradó molárisok occlusalis barázdájában. [Examination of the Streptococcus mutant colonization and remineralization in the occlusal fissures of permanent molar teeth after the application of chlorhexidine/ fluoride content dental varnishes.] Árkövy Assembly, Szeged, May 5-7, 2016

Lipták L, Bársony N, Twetman S, Madléna M. Effects of chlorhexidine-fluoride varnishes in occlusal fissures of permanent molars. 21th Congress of EADPH Budapest, Sept. 29- Oct. 1, 2016.

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Dentistry and Orthodontic Society of the Hungarian Dental Association (MFE), Pécs, November 17-19, 2016

Lipták L, Bársony N, Twetman S, Madléna M. Klórhexidin és fluorid tartalmú lakkok remineralizációra kifejtett hatásának vizsgálata maradó molárisokon. [Examination of the effects of chlorhexidine and fluoride content dental varnishes on remineralization in permanent molar teeth.] I. Szeged Dental Science Meeting and Conference, Szeged, September 15-16, 2017

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Publication not related to the dissertation

Chapter from a book

Madléna, M., **Lipták, L.**, Gyulai-Gaál, Sz.: A fogak sérülései (Tooth Injuries) In: Radnai, M., Fazekas, A. (ed.), Fogászat (Dentistry), Medicina, Budapest, 2018 (to be published soon)