Pesquisa Brasileira em Odontopediatria e Clínica Integrada

ISSN: 1519-0501

apesb@terra.com.br

Universidade Federal da Paraíba

Brasil

HASIC BRANKOVIC, L; PRCIC KONJHODZIC, A; AJANOVIC, Muhamed; LEKIC, M; KORAC, F; KOBASLIJA, S

Effect of Three Topical Fluoride Solutions on Fluoride Level in Plaque

Pesquisa Brasileira em Odontopediatria e Clínica Integrada, vol. 11, núm. 1, enero-marzo, 2011, pp. 7-12

Universidade Federal da Paraíba

Paraíba, Brasil

ISSN - 1519-0501 DOI: 10.4034/PBOCI.2011.111.01

Effect of Three Topical Fluoride Solutions on Fluoride Level in Plaque

Efeito de Três Soluções Tópicas de Flúor no Nível de Flúor do Biofilme Dentário

L HASIC BRANKOVIC[1], A PRCIC KONJHODZIC[1], Muhamed AJANOVIC[2], M LEKIC[3], F KORAC[3], S KOBASLIJA[4]

[1]Department of Dental Pathology, Restorative Dentistry and Endodonthics, Faculty of Dentistry, University of Sarajevo, Sarajevo.
[2]Department of Prosthodontics, Faculty of Dentistry, University of Sarajevo, Sarajevo.
[3]Department for Medical Chemistry, Medical Faculty, University of Sarajevo, Sarajevo.
[4]Department of Preventive Dentistry, Faculty of Dentistry, University of Sarajevo, Sarajevo.

RESUMO

Objetivo: Avaliar a ação no biofilme dental após a aplicação de três soluções de flúor tópico: 1% TIF4, NaF 1% e solução de Aminfluorid. A eficiência das três soluções foi estimada através da concentração de íons de flúor.
Método: As concentrações de íons de flúor foram medidas com um eletrodo para flúor. 60 voluntários adultos, divididos em três grupos (20 voluntários para cada grupo, uma substância por um grupo) participaram da pesquisa. Os sujeitos permaneceram sem higiene oral por 48 horas antes do experimento. Amostras do biofilme dentário foram tomadas antes da aplicação das soluções de flúor, e novamente depois de 5, 30, 60 e 120 minutos após o tratamento.
Resultados: A concentração de flúor no biofilme dental não foi estatisticamente diferente para as três soluções testadas.
Conclusão: Não houve diferença clinicamente significativa na eficácia nas três soluções tópicas de flúor utilizadas, apesar das diferenças nos valores do pH. Apenas uma diferença estatisticamente significante foi observada após 60 minutos entre o fluoreto de sódio e o tetrafluoreto de titânio, mas ela desapareceu após 120 minutos.

DESCRITORES

Biofilme dentário; Fluoreto de sódio; Fluoretos; Eletrodos íon-seletivos.

ABSTRACT

Objective: To examine process inside plaque after application of three topical fluoride solutions: 1% TiF4, 1% NaF and Aminfluorid solution. Efficiency of three of these was estimated through concentrations of fluoride ions.
Methods: Fluoride ions concentrations were measured and demonstrated as potential of fluoride electrode. 60 adult volunteers, divided in three groups (20 volunteers for each group, one agent per one group) have participated in the research. Subjects refrained of oral hygiene for 48 hours before the experiment. Plaque samples were taken before the application of fluoride solutions, and again after 5, 30, 60 and 120 minutes following the treatment.
Results: Fluoride concentrations in plaque were not significantly different for three tested solutions.
Conclusion: There isn't clinically significant difference in efficacy of three used topical fluoride agents, despite their pH values differences. Only one statistically significant difference appeared after 60 minutes between sodium fluoride and titanium tetra fluoride, but it disappeared after 120 minutes.

KEYWORDS

Dental plaque; Sodium fluoride; Fluorides; Ion-selective electrodes.

INTRODUCTION

Fluoride has been widely accepted as one of the most effective way to prevent and treat tooth decay. No other drug has had quite impact on oral health as fluorides in the past 50 years[1].

As a key agent in decreasing prevalence of dental caries, fluorides demonstrate their effects on at least three ways: (1) Taking a part in early processes of demineralization and remineralization; (2) Changing chemical structure and quality of enamel, by improvement hydroxyl-apatite crystals, and (3) Changing ability of plaque bacteria to produce acids[2,3].

But recent studies show that earlier systemic fluorides effect doctrine is not entirely correct. Belief that systemic fluoride intake during tooth development results implant of fluoride ions into enamel crystal, and high acid- resistance of enamel eventually is changed.

Nowadays researches put events in saliva, plaque and plaque fluid in focus of interesting.

Presence of fluoride ions in saliva, plaque and in plaque fluid is the key factor for beginning of caries lesion, and not the quantity of fluorides incorporated into the enamel structure previously[2,4-6].

Caries occurs at predominantly at inaccessible stagnation sites where plaque removal is difficult. For such agents as fluoride and antimicrobials to provide effective protection against caries they must reach their sites of action within plaque, i.e., acidogenic bacteria within the plaque biomass, and/or underlying tissue. The extent to which fluoride penetrates plaque biofilm is therefore critical[7].

Titanium tetra- fluoride was used as a fissure sealant, agent for treatment of dentin hypersensitivity, agent for preventing enamel erosions, and so on[8-12].

The most interesting fact regarding titanium tetra-fluoride is its very low pH. Sodium fluoride is nearly neutral, and Aminfluoride is slightly alkaline, so it was interesting to examine does pH of fluoride agents in equal concentrations of active substance has influence on fluoride concentration in plaque and plaque fluid.

The aim of this study was to investigate the effects of two well established fluoride agents (sodium- fluoride and aminfluoride) compared with titanium tetra- fluoride, whose effect in plaque was not so well investigated till now.

MATERIAL AND METHODS

Volunteers, both sexes, age 18-55, good general health, without systemic disorders and GERB, who haven't take any antibiotics in 30 days before the experiment, who don't take any drugs which can decrease salivary flow, they don't were mobile prosthodonthics appliances, whose salivary flow rate of unstimulated saliva was 1ml/1minute participated in this study[13].

Final intraoral inspection excluded those who had active carious lesions in areas where plaque should be collected and those who had more than one fixed crown.

60 participants were divided into three groups, 20 volunteers each. They received professional teeth cleaning treatment, but without fluoride containing paste. After complete cleaning, they refrained of any oral hygiene for the next 48 hours.

During plaque accumulation period they were asked to refrain of consummation of fluoride reach beverages or food (tea or sardines for example), consummation of chewing gums was forbidden too. Twelve hours before the experiment (during the night-time) volunteers didn't take any food, except water. Experimental procedure was performed in early morning.

Plaque Collecting Procedure

Before the treatment plaque samples were collected from easy accessible buccal surface of teeth 15 and 16 after short drying with compressed air, avoiding deep proximal interdentally and sub gingival areas.

Plaque samples were taken by scratch movements, with little plastic spatulas (plastic coffee spoon) in other to avoid contamination with fluorides from dental instruments and surface layer of possible demineralised enamel (unused plastic is chemically clean).

Topical Fluoride Treatment Procedure

One fluoride agent was fabricated (Aminfluorid®Belupo), and two other were made as 1% solutions in distilled deionizied water.

One of three topical fluoride solutions was choose for treatment. 2 ml of solution was applied on teeth of upper and lower jaw, carefully with cotton pellet, during one minute; while saliva vacuum collector collected possible extent of fluoride solution.

After topical fluoride treatment plaque samples were taken from teeth 25/26 after 30 minutes, from teeth 35/36 after 60 minutes, and from teeth 45/46 after 120 minutes, on previously described way (Table 1).

Table 1. Schematic overview of experimental procedure-clinical part.

Sample/time in minutes	Sample taken from teeth
Before the treatment	Teeth 15/16
30 minutes after the treatment	Teeth 25/26
60 minutes after the treatment	Teeth 35/36
120 minutes after the treatment	Teeth 45/46

All samples were prepared and fluoride concentrations were measured in the same day, a few hours after they were collected.

Activation, Initialization and Testing of Fluoride-Selective Electrode-Procedure

Fluoride concentration was determined with fluoride-selective electrode made by WTW type F 500 in combination with reference electrode type R 503, in pH/ion meter produced by WTW (InoLab®pH-level 1)

A whole system was tested with standard solution (Fluoride Standard Solution 10g/l F-) and than solutions of known concentrations of active substances were made. By measuring of electrode potential in those standard solutions, we could construct curves.

In solutions with high concentration of active substance, electrode show very high level of confidence (R2=0, 9969). Solutions with low concentration of active substance had just a little bit lower level of confidence (R2=0, 9424), which is more than sufficient for this type of research[14,15].

Plaque Sample Preparation Procedure

Plaque sample was diluted with 1 ml of 1 mol/l perchloric acid in order to perform acid extraction process[5].

Afterward samples were placed on laboratory vibrator for preparing plaster models, during 2 minutes on 60 Hz frequency, in order to free majority of fluoride ions bonded in solid plaque particles.

Next step was to neutralize acid after 30 minutes with same volume of 1mol/l NaOH. 30 minutes after 2ml of TISAB solution was added, and for the next 30 minutes stabilisation of sample was expected.

Measured value was considered stabile if it was unchanged for three seconds. Between two measurements, booth, fluoride-selective and reference electrode were washed-out with distilled deionized water and dried with super-absorbing paper.

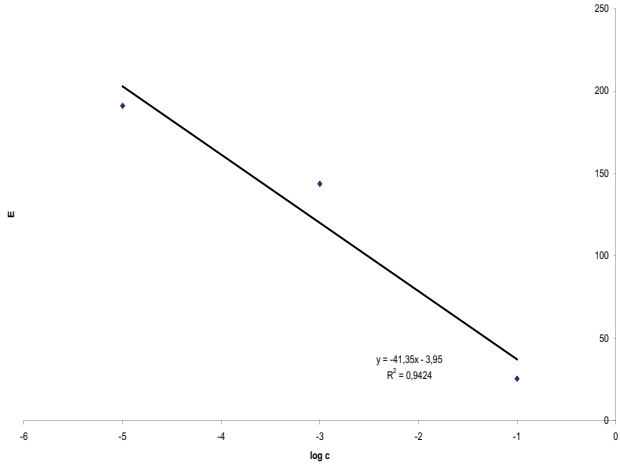

Figure 1. Calibrated curve of fluoride selective electrode-smaller concentrations of active substances.

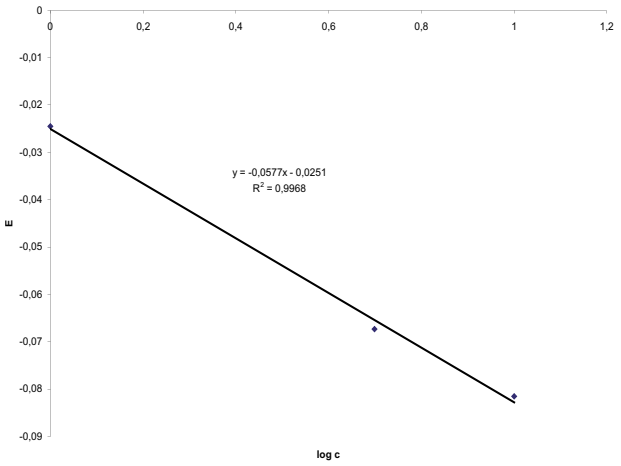

Figure 2. Calibrated curve of fluoride selective electrode-bigger concentration of active substances.

RESULTS

Results of arithmetic means and standard deviations are given in Table 2. All results are given in mV. In Table 3 are correspondent values of concentration, calculated on calibration curve base.

The most commonly used statistic method for evaluation the impact of one or more factors on some process is ANOVA (analyse of variance).

This paper treat one-factor problem: the effect of different agents on concentrations of fluoride ions in plaque. Overviews of statistical analyses are given in Tables 4, 5, 6 and 7.

Table 2. Arithmetic means of measured electrode potentials with standard deviation. Values presented in mV.

	0´	30´	60´	120´
Aminfluorid	194,74 ± 12,89	163,105 ± 18,31	173,975 ± 19,04	178,655 ± 20,79
Titaniumtetrafluorid	197,13 ± 11,11	171,545 ± 20,93	183,09 ± 16,60	183,37 ± 17,30
NaF	195,18 ± 11,39	163,18 ± 19,55	168,175 ± 23,39	174,875 ± 22,40

Table 3. Arithmetic means of electrode potential of fluoride ions in plaque and correspondent values of mass concentrations and molar concentrations.

	Potential E (mV)	Mass concentration (µg/l)	Molar concentration (µmol / l)
A 0'	194,74	24,3206	1,28
T 0'	197,13	21,2899	1,1205
N 0'	195,18	23,7319	1,249
A 30'	163,105	141,5884	7,452
T 30'	171,545	88,4946	4,6576
N 30'	163,18	140,9983	7,42096
A 60'	173,975	77,2947	4,0681
T 60'	183,09	46,5280	2,4488
N 60'	168,175	106,7618	5,619
A 120'	178,655	59,5621	3,1348
T 120'	183,37	45,8082	2,411
N 120'	174,875	73,5165	3,8693

Legend: A- Aminfluorid; T- titaniumtetrafluorid; N- NaF; 0-native sample; 5-five minutes sample; etc.

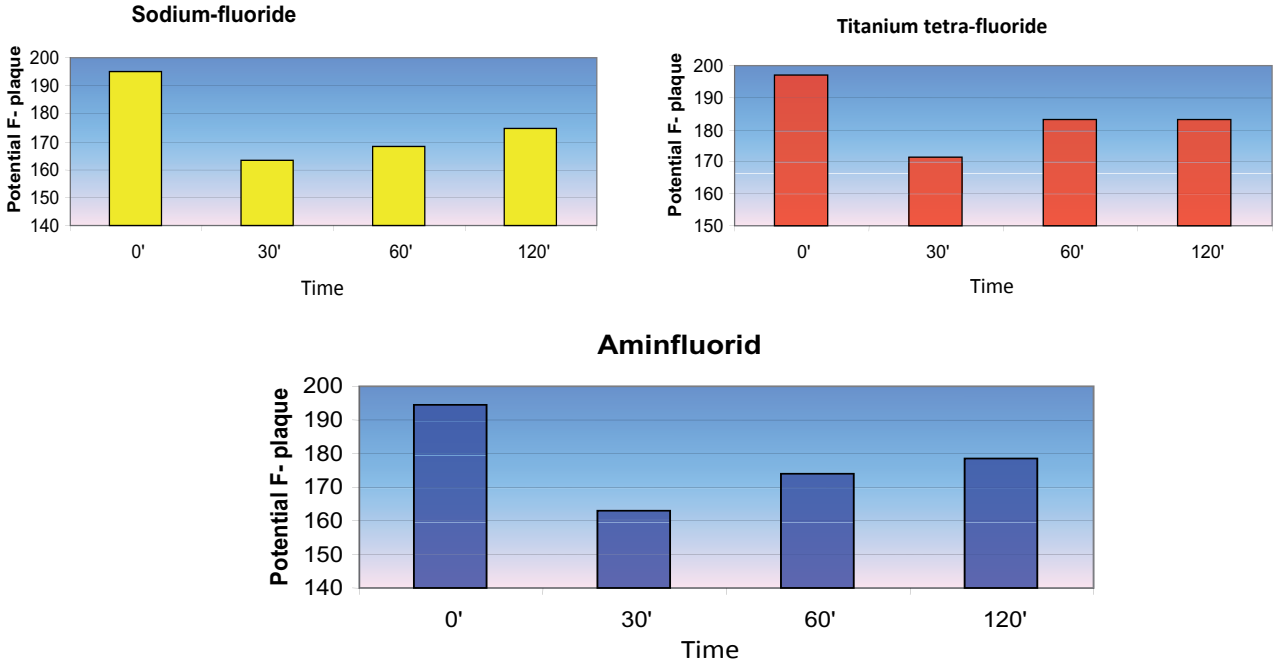

Figure 3. Overview of arithmetic mean change depending on action of three used fluorides agents.

Table 4. Results of statistic analysis.

Groups	Count	Sum	Average	Variance		
N0-potential F- plaque	20	3903,6	195,18	129,7691		
T0- potential F- plaque	20	3942,6	197,13	123,4317		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	38,025	1	38,025	0,300355	0,586865	4,098172
Within Groups	4810,814	38	126,6004			
Total	4848,839	39				

Table 5. Results of statistic analysis.

Groups	Count	Sum	Average	Variance		
N30- potential F- plaque	20	3263,6	163,18	382,3712		
T30- potential F- plaque	20	3430,9	171,545	438,0973		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	699,7322	1	699,7322	1,705689	0,199397	4,098172
Within Groups	15588,9	38	410,2343			

Table 6. Results of statistic analysis.

Groups	Count	Sum	Average	Variance		
N60- potential F- plaque	20	3363,5	168,175	547,1557		
T60- potential F- plaque	20	3661,8	183,09	275,5031		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2224,572	1	2224,572	5,408251	0,025479	4,098172
Within Groups	15630,52	38	411,3294			
Total	17855,09	39				
Total	16288,63	39				

Table 7. Results of statistic analysis.

Groups	Count	Sum	Average	Variance		
N120- potential F- plaque	20	3497,5	174,875	501,8399		
T120- potential F- plaque	20	3667,4	183,37	299,4485		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	721,6503	1	721,6503	1,801225	0,187529	4,098172
Within Groups	15224,48	38	400,6442			
Total	15946,13	39				

Table 8. F-relation values and overview of statistically significant differences acquired by application of ANOVA (Fcrit=4,098172).

Agents	F	Statistically significant differences
A 0'-potential of F- plaque, N0- potential of F- plaque	0,013079	No
A 0'- potential of F- plaque, T0- potential of F- plaque	0,394347	No
N 0'- potential of F- plaque, T0- potential of F- plaque	0,300355	No
A 30'- potential of F- plaque, N30- potential of F- plaque	0,000157	No
A 30'- potential of F- plaque, T30- potential of F- plaque	1,842024	No
N 30'- potential of F- plaque, T30- potential of F- plaque	1,705689	No
A 60' potential of F- plaque - N60- potential of F- plaque	0,73963	No
A 60'- potential of F- plaque, T60- potential of F- plaque	2,604525	No
N 60'- potential of F- plaque, T60- potential of F- plaque	5,408251	Yes
A 120'- potential of F- plaque, N120- potential of F- plaque	0,305951	No
A 120'- potential of F- plaque, T120- potential of F- plaque	0,607708	No
N 120'- potential of F- plaque, T120- potential of F- plaque	1,801225	No

Legend: A - samples treated with Aminfluorid; N - samples treated with NaF and T - samples treated with titanium tetrafluoride.

DISCUSSION

Attempt to compare those results with other authors seems to be the hardest part of investigation since the next reasons: a) Other authors report their results as concentration per mass unit, since they weight plaque so units are µg/g (ppm) wet whole plaque or ng/g (ppb-parts per billion); b) In this experiment plaque samples were not weight since it was technically very demanding (insufficient precise of mechanical scale, impracticality of weighting in situ, possible contamination of samples during transport to the laboratory)

So, discussion of these results is not based on authentic values, but on estimation. Although, our results are comparable with other based on estimation of several independent authors concerning the ratio of plaque fluid and dry leftovers of plaque.

Previous authors estimated proportion: relative amount of plaque fluid in whole plaque is 30%[16,17].

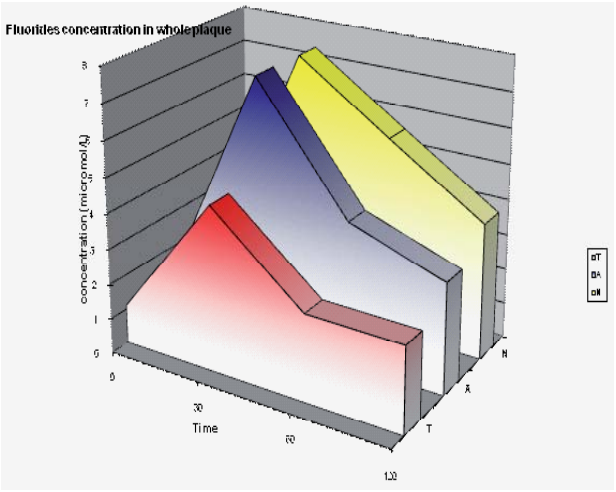

Figure 4. Fluoride concentrations in whole plaque.

Table 9. Results of previous studies of fluoride concentrations in whole plaque and in plaque fluid- overview.

Author	Result- fluoride concentration in whole plaque	Result- fluoride concentration in plaque fluid
Duckworth et all.[18]	1,91 ngF/mg of whole plaque	Ø
Zero et all.[19]	1,9 nmol/g of whole plaque	Ø
Gajić[20]	5-10 ppm F; 10-20 ppmF (dry leftovers of plaque)	Ø
Rölla, Ekstrand[2]	5-10 ppmF/mass unit of whole plaque	Ø
Watson et all.[7]	920 ppm F	Ø
Vogel et all.[21]	1,8 µg/g	12 µmol/l
Vogel et all.[22]	1,24 µg/g	8,31 µmol/l
Vogel et all.[6]	≈2,8 µg/g	≈13 µmol/l
Vogel et all.[5]	Ø	16,5 µ mol/l
Tanaka et all.[17]	Ø	*0,03 µg/ g of whole plaque
Our result	23,11µg/l; 1,21 µmol/l	*4,03 µmol/l

* Results obtained on estimated ratio of plaque fluid and whole plaque.All results are in untreated, native, 48 hours old plaque.

CONCLUSION

There isn't clinically significant difference in efficacy of three used topical fluoride agents, despite their pH values differences. Only one statistically significant difference appeared after 60 minutes between sodium fluoride and titanium tetra fluoride, but it disappeared after 120 minutes.

Method of fluoride concentration evaluation through potential of fluoride electrode seems to be fully suitable, valid and accurate, rather undemanding and economical as well. This method can be strongly recommended as appropriate technique for such kind of measurements.

REFERENCES

1. Bemie KM. Deconstructing fluoride use - pros and cons. Contemp Oral Hygiene 2005; 5(7):8-12.

2. Rölla G, Ekstrand J. Fluoride in oral fluids and dental plaque. In: Fejerskov O, Ekstrand J, Burt BA, Fluoride in dentistry. 2nd. ed. Copenhagen: Munksgard; 1996.

3. Jones S, Burt BA, Petersen PE, Lennon MA. The effective use of fluorides in public health. Bull World Health Organ 2005; 83(9):670-6.

4. Lindhe J, Karring T, Land NP. Clinical Periodontology and Implant Dentistry. 4th. ed. Oxford: Blackwel Publishing Company; 2003.

5. Vogel GL, Carey CM, Ekstrand J. Distribution of fluoride in saliva and plaque fluid after a 0,048 mol/l NaF rinse. J Dent Res 1992; 71(9):1553-7.

6. Vogel GL, Mao Y, Carey CM, Chow LC, Takagi S. In vivo fluoride concentrations measured for two hours after a NaF or a novel two-solutios rinse. J Dent Res 1992; 71(3):448-52.

7. Watson PS, Pontefract HA, Devine DA, Shore RC, Nattress BR. Penetratin of fluoride into natural plaque biofilms. J Dent Res 2005; 84(5):451-5.

8. Van Rijkom H, Ruben J, Huysmans MC, Truin GJ, Mulder J. Erosion-inhibiting effect of sodium fluoride and titanium tetrafluoride treatment in vitro. Eur J Oral Sci 2003; 111(3): 253-7.

9. Büyükilmaz T, Øgaard B, Duschner H, Ruben J, Arends J. The caries- preventive effect of titanium tetrafluoride on root surfaces in situ as evaluated by microradiography and confocal laser scaning microscopy. Adv Dent Res 1997; 11(4):448-52.

10. Şen BH, KazemiRB, Spångberg SW. Permeability changes of dentine treated with titanium tetrafluoride. J Dent 1999; 27(7):531-8.

11. Wei SH, Soboroff DM, Wefel JS. Effects of titanium tetrafluoride on human enamel. J Dent Res 1976; 55(3):426-31.

12. Jordan TH, Weffel JS, Brennan D, Brooks C, Hanusa T. The reaction between TiF4 and apatite. J Dent Res 1980; 59(Spec. Iss. A):523, abst. 1017.

13. Zero DT, Fu J, Anne KM, Cassata S, McCormack SM, Gwinner LM. An improved intra-oral enamel demineralization test model for the study of dental caries. J Dent Res 1992; 71(Spec Iss):871-8.

14. Campus G, Lallai MR, Carboni R. Fluoride concentration in saliva after use of oral hygiene products. Caries Res 2003; 37(1):66-70.

15. Poureslami HR, Torkzadeh M, Sefadini MR. Study of changes in phosphate, calcium and fluoride ions in plaque and saliva after the administration of a fluoride mouth rinse. J Indian Soc Pedod Prev Dent 2007; 25(3):122-5

16. Tatevosian A. Fluoride in dental plaque. J Dent Res 1990; 69 (Spec Iss):654-52.

17. Tanaka M, Margolis HC. Release of mineral ions in dental plaque following acid production. Arch Oral Biol 1999; 44(3):253-8.

18. Duckworth RM, Morgan SN, Gilbert RJ. Oral fluoride measurements for estimation of the anti-caries efficacy of fluoride treatments. J Dent Res 1992; 71:836-40.

19. Zero DT, Raubertas RF, Fu J, Pedersen AM, Hayes AL, Featherstone JD. Fluoride concentrations in plaque, whole saliva and ductal saliva after application of home-use topical fluorides. J Dent Res 1992; 71 (11):1768-75.

20. Gajić M. Fluoridi u preventinoj stomatologiji. 2 izd. Beograd: Nauka, 2002.

21. Vogel GL, Mao Y, Chow LC. Fluoride in plaque fluid, plaque and saliva measured for 2 hours after a sodium fluoride monofluorophosphate rinse. Caries Res 2000; 34(5):404-11.

22. Vogel GL, Mao Y, Carev CM, Chow LC. Increased overnight fluoride concentrations in saliva, plaque and plaque fluid after a novel two-solution rinse. J Dent Res 1997; 76(3):761-7.

Recebido/Received: 22/04/10
Aprovado/Approved: 16/08/10

Correspondence:
Lajla Hasic Brankovic
Faculty of Dentistry
Bolnicka 4a 71000 Sarajevo BiH
E-mail: lajlabrankovic@gmail.com