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SALIVARY FLUORIDE CONCENTRATION DURING ORTHODONTIC TREATMENT USING TWO TYPES OF ADHESIVES

КОНЦЕНТРАЦИЈАТА НА САЛИВАРНИТЕ ФЛУОРИДИ ЗА ВРЕМЕ НА ОРТОДОНТСКИОТ ТРЕТМАН СО УПОТРЕБА НА ДВА ТИПА НА АХЕЗИВИ

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Abstract

The importance of fluoride concentration in saliva is well established, based on the main role of the fluoride ions, that is decreasing the demineralization and enhancing the remineralization of enamel, even in patients with carious risk. The **aim** of the present study is to measure the fluoride concentration in saliva in patients under fixed orthodontic treatment with metal braces by using two different types of orthodontic adhesives – composite and resin-reinforced glass ionomer cements. The subjects for this study were 60 patients scheduled for orthodontic therapy in the Department of Orthodontics, University Clinic of Dentistry "St. Pantelejmon" – Skopje. Patients were divided in two groups according to the adhesive type used for bonding: - The first group compromised of 30 patients whose braces were bonded with composite adhesive, - The second group comprised of 30 patients whose braces were bonded with resin-reinforced glass ionomer adhesive (RRGICs). The **results** showed that resin-reinforced glass ionomer adhesive (RRGICs) releases fluoride one day after bonding the braces and there was rapid decrease of fluoride concentration in saliva one month later. The outcome was different in the patients with composite adhesive where we had a slow decrease of fluoride concentration in T1 period. **Key words:** Demineralization; Composite; Glass ionomer cement.

Апстракт

Важноста на концентрацијата на флуориди во плунката е добро утврдена врз основа на главната улога на флуоридните јони, што ја намалува деминерализацијата и ја подобрува реминерализацијата на емајлот, дури и кај пациенти со ризик од кариес. **Целта** на оваа студија е мерење на концентрацијата на флуориди во плунката кај пациенти под фиксен ортодонтски третман со метални брекети со користење на два различни ортодонски атхезиви - композитни и смолести модифицирани глас-јономер цементи. Предмети за оваа студија беа 60 пациенти закажани за ортодонтска терапија во одделот за Ортодонција, Универзитетска клиника за стоматологија "Св. Пантелејмон"- Скопје. Пациентите беа поделени во две групи според типот на атхезивот користен за врзување: - Првата група од 30 пациенти кај кои е користен композитен атхезив; - Втората група од 30 пациенти, каде е користен смолесто модифициран глас-јономерен атхезив (RRGICs). **Резултатите** покажаа дека смолесто модифициран глас-јономерен атхезив (RRGICs), го ослободува флуоридот еден ден по поврзувањето на протезите и брзото намалување на концентрацијата на флуорид во плунката еден месец подоцна. Ситуацијата е друга кај пациентите со композитен атхзив, каде што имаме бавно намалување на концентрација на флуорид во Т1 период. **Клучни зборови:** Деминерализација, Композит, Глас-јономер цемент

Introduction

Cleaning orthodontic brackets and bands represents a challenge for the patient wearing them, these attachments act as plaque-retaining structures leading to demineralization of adjacent enamel[1].

Recent studies have shown that 50% to 75% of all orthodontic patients develop demineralization on the labial surface during fixed appliance therapy[2, 3].

The importance of fluoride concentration in saliva is well established, based on the main role of the fluoride ions, which is decreasing the demineralization and enhancing the remineralization of enamel, even in patients with carious risk[4, 5, 6].

The absorption of the fluoride ions from the oral fluids in the sound enamel is low and limited at a neutral pH. If the fluoride ions are present in the mouth at the time when the pH is decreasing and the carious lesion is starting, their effect is to inhibit the demineralization of the enamel by promoting remineralization[7, 8, 9, 10].

In Orthodontics, white spot lesions and marginal gingivitis raise much concern among professionals, who have been tackling this problem by making use of materials to decrease and prevent such damage to oral health, among which are the ionomer cements (GICs). Since their introduction in 1971, GIC have been employed for a number of applications mainly due to its chemical adhesion to enamel, dentin and other surfaces in addition to rereleasing fluoride[19].

The evolution of GIC properties has contributed to the decrease in dental caries among orthodontically treated patients due to the biological and chemical characteristics of the material[20].

Despite these favorable characteristics, the adhesion of brackets to dental enamel is not entirely adequate, often not being strong enough to resist to masticatory forces and orthodontic movements[21].

In order to overcome this problem, manufacturers have developed hybrid products by incorporating a resin matrix system to GICs, thus combining the retentive capacity of resins with the well known beneficial properties of GICs[22].

These materials were denominated as resin-reinforced glass ionomer cements (RRGICs).

RRGICs can be used in Orthodontics due to their resistance to orthodontic forces, thus becoming a useful material for bonding orthodontic accessories and preserving the dental enamel. It is accepted that the RRGICs analysed in this study release fluoride and are used for bonding brackets and attaching[23].

The aim of the present study is to measure fluoride concentration in saliva in patients under fixed orthodontic treatment with metal braces by using two different types of orthodontic adhesives - composite and resin-reinforced glass ionomer cements.

Material and methods

The subjects for this study were 60 patients scheduled for orthodontic therapy in the Department of Orthodontics, the University Clinic of Dentistry "St. Pantelejmon" - Skopje. Patients were divided in two groups according to the adhesive type used for bonding:

- The first group was composed of 30 patients whose braces were bonded with composite adhesive
- The second group comprised of 30 patients whose braces were bonded with resin-reinforced glass ionomer adhesive (RRGICs).

All experimental procedures were conducted in accordance with the Declaration of Helsinki's recommendations guiding physicians in biomedical research involving human subjects. All participants and their parents or guardians received written information about the aims and design of the study and signed a written informed consent form.

The criteria for inclusion were as follows: permanent dentition period, crowding, age 12-25 years, good general health, general dentistry completed and consent to participate. Criteria for exclusion were: diabetes mellitus, autoimmune connective tissue diseases, any syndrome and antibiotic therapy in the last 3 months. The orthodontic process in all subjects started with 0.012 NiTi. Subjects were required to establish good oral hygiene status, none used supplementary fluoride during the study and none of them received any periodontal procedure before or during the active orthodontic treatment.

Saliva collection

Samples of saliva were collected into plastic specimen containers as wholly unstimulated saliva for a period of two minutes in three periods:

T_0 – collecting saliva before bonding the braces
T_1 – collecting saliva the day after bonding
T_2 – collecting saliva one month later.

The fluoride content of the saliva samples was analysed by the Taves[(24)] micro diffusion method as described in detail by Zero at al.[(25)]. The volume of the saliva was adjusted to 3ml with double deionized water, and 0.1 ml of 1.65 mol/l NaOH was added to the central trap. One milliliter of 6 mol/l HCl, saturated with hexamethyldisiloxane, was added to the sample before the dish was sealed. The samples were rotated for 18 hours on a rotary shaker at 80 rpm. At the end of the diffusion period, the NaOH traps were removed. The samples contained in the traps were dried at 65^{0}C for 2 hours, and buffered with 1 ml of 0.34 mol/l acetic to a final pH at 5.0. Fluoride was then measured by a fluoride ion-specific electrode (Model 960900, Orion Research, Inc.).

The electrode was gauged every day by using standard solution of fluoride (0.05, 0.010, and 0.19 ppm). Fluoride release was measured at T_0, T_1 and T_2 periods.

Results

Orthodontic brackets and bands act as biofilm-retaining structures, which can cause demineralization of the adjacent enamel during orthodontic treatment.

Therefore, an effective prevention against enamel demineralization adjacent to the orthodontic attachments is necessary.

The amount of fluoride release from each material during the study period is shown in Table 1 and 2.

Table 1. Descriptive analysis (F in saliva in T0,T1 and T2) **Glas-jonomer cement**

	Glas-jonomer cement			
	T_0	T_1	T_2	p value T_2-T_1/T_2-T_0/T_1-T_0
F	0.04± 0.02	0.0418± 0.02	0.0399± 0.02	0.00008**/0.77/0.0001**

p (Friedman ANOVA; post hoc Wilcoxon-Matched pairs test)**p<0.01

Table 2. Descriptive analysis (F in saliva in T0,T1 and T2) - **Composite**

	Composite			
	T_0	T_1	T_2	p value T_2-T_1/T_2-T_0/T_1-T_0
F	0.04± 0.081	0.039± 0.018	0.04± 0.018	1.0 ns/0.53 ns/0.55ns

p (Friedman ANOVA; post hoc Wilcoxon-Matched pairs test)

For the group of patients with resin-reinforced glass ionomer adhesive (RRGICs) we obtained a significant higher fluoride release of 0.0418 mg/L in T_1 period, respectively at the first day and than a rapid decrease at T_2 period, after one month, respectively 0.0399 mg/L comparing with the fluoride concentration at T_0 period 0.04 mg/L.

The situation was different in patients with composite adhesive where we observed a slow decrease of fluoride concentration at T_1 period, 0.039 mg/L and stabilization of fluoride concentration as the situation before adhering the braces, respectively 0.04 mg/L in T_2 period.

Discussion

In order to reduce the occurrence of such demineralization processes, the orthodontic attachments should be maintained with materials which can release fluoride and provide adequate adhesion to both enamel and stainless steel[11].

Some studies have shown that part of the fluoride release from these materials is absorbed by adjacent dental tissues, making them more resistant to secondary caries in addition to reducing demineralization and increasing remineralization. Nevertheless, both the magnitude and the duration of the anticariogenic effects of fluoride depend mainly on its concentration and retention time within the oral cavity. Therefore, it is better to have fluoride released for longer periods of time rather than the initial “burst effect” of the material, since the longevity of the orthodontic appliance should be taken into account[26].

Kielbassa et al. reported that RRGICs have an anticariogenic effect compared to non-fluoridated composites. This anticariogenic effect is crucial in the orthodontic treatment[2].

Salivary fluoride levels vary from 0.01-0.10 mg/L depending on the water fluoride usage and the diet of the individual. Langerolf and Oliveby stated that saliva influences caries attack mainly by its rate of flow and by its fluoride content[1,2].

Daws at al. quote the normal concentration of fluoride in saliva as being about 0.019 mg/L and also confirmed that salivary fluoride levels were independent of flow rates, and that higher concentration of fluoride in saliva led to the formation of calcium fluoride which had a longer clearance time[13].

Many researchers now believe that continuous low concentration of fluoride in saliva, particularly at the plaque/saliva/enamel interface is necessary for caries prevention[14].

Leverett et al. showed that caries-free subjects had higher salivary fluoride than high caries subjects[15].

Shields et al. showed that subjects with no caries experience, from both fluoridated and non-fluoridated communities, had salivary fluoride levels of 0.04 mg/L or greater, whereas high caries subjects from both fluoridated and non-fluoridated communities had salivary fluoride levels of 0.02 mg/L or less[16].

Duggal et al. also showed consistent inverse relationship between salivary fluoride concentration and dental caries in 272 children[17].

Sjorgen et al. reported that a caries-active group in Sweden had lower salivary fluoride levels than a caries-inactive group[18]. Also they reported that type, shape and surface area of the cement can significantly influence the fluoride release process.

The model of the fluoride levels variation in this study is similar to other studies and is explained by the CaF_2 formation, which represent the major product of the reaction between fluoride with enamel, and which precipitates wherever the dental hard tissues are exposed to high concentrations of fluoride, inhibiting the enamel demineralization and enhancing the remineralization[8, 9].

CaF_2 is relatively stable at a neutral pH. When the pH is decreased, CaF_2 dissociates and fluoride ions are released and adsorbed in enamel. The dissolution of the CaF_2 formed on the teeth surfaces, in saliva and in dental bacterial plaque is the key of the preventive effect of fluoride in saliva.

The preventive effect of fluoride is unquestionably connected with the fluoride ions reserve in saliva in the periods when the pH is decreasing in the oral cavity.

Conclusion

The results showed that resin-reinforced glass ionomer adhesive (RRGICs) releases fluoride one day after bonding the braces and there is rapid decrease of fluoride concentration in saliva one month later. The outcome was different in patients with composite adhesive where we had a slow decrease of fluoride concentration in T_1 period.

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