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Can fluoride or tri-calcium phosphate varnishes alter salivary and plaque pH in athletes who consume soft drinks?

Abstract

Background: Plaque and saliva pH are the main factors that facilitate the caries process. Consumption of acidic soft drinks is one of the factors responsible for pH changes in the oral cavity. Athletes commonly consume soft drinks. The purpose of this study was to evaluate the effects of two types of varnishes (fluoride and tri-calcium phosphate, TCP) on plaque and saliva pH of professional athletes who consume soft drinks.

Methods: In this clinical study, 40 professional athletes aged 18-30 years were first randomly divided into two groups: Fluoride varnish (Sultan®, USA) and TCP varnish (3M®, ESPE, USA). At the first session, the baseline pH of plaque and saliva was measured using a plaque indicator kit (GC, USA) and pH meter (Hana, model AZ 8686, Italy). Then, the varnishes were applied. After 3 weeks, pH value of the participants was examined and varnishes were applied again, following by pH measurements at weeks 6 and 12. The data were analyzed using Repeated Measures ANOVA.

Results: Applying fluoride varnish or TCP varnish did not cause any significant difference in saliva and plaque pH during the assessment periods ($p>0.05$).However, higher buffering capacity was observed among the athlete who had low pH at the baseline ($p<0.05$).

Conclusion: Neither of the varnishes caused changes in plaque and saliva pH in this study. But the buffering capacity increased in athletes with low baseline pH.

Keywords: fluoride varnish, tri-calcium phosphate, saliva pH, plaque pH, athletes, soft drinks

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Introduction

Dental caries affects oral health of different groups of a society. Reduction of pH in dental plaque and saliva can lead to dental caries.[1] Increased concentration of fermentable carbohydrates after consumption of sweets and beverages accompanied by low buffering capacity of saliva may cause continuous drop in salivary and inter-proximal plaque pH. Low pH of the oral cavity provides a suitable environment for cariogenic bacteria. A pH of 5.5 or less provides a favorable condition for enamel decalcification and further decay, which will influence tooth function and esthetics.[2,3]

In 1940, Stephen was the first one to show that 2-5minutes after a single sucrose dose, salivary pH drops and the condition lasts for 10minutes; after 20-60minutes it returns to its initial pH value, depending on the salivary characteristics or caries prevention methods that a person uses.[1] The more sweets are consumed, the less there are possibilities for returning to the baseline pH, and the greater is the risk for caries development.[1,2] Athletes, especially the professional ones, are among the most frequent consumers of different types of soft drinks and energetic acidic sweet drinks; since they must prevent dehydration during their heavy exercises, losing body fluids and facing imbalance of electrolytes.[4–7] Excessive consumption of sweet drinks causes low pH and increases the possibility of caries and subsequent tooth loss. As the result, masticatory disability, pain, discomfort and esthetic problems ensue,[8] which may impair participation on national or international competitions.[9]

Different caries preventive methods have been suggested for increasing the pH after consumption of sweet foods, e.g., tooth mineralizing products such as fluoride or calcium-phosphate containing varnishes, mouthwashes, and Xylitol chewing gums.[1] Fluoride varnishes have extensively been used over 40 years in Dentistry, the most common type of which is 5% sodium fluoride varnish.[10] Some studies show that varnishes allow an increase in both fluoride and pH levels of saliva.[11-21] In addition to fluoride varnish, other types of varnishes such as ones containing tri-calcium phosphate (TCP) has been proposed to increase salivary pH and therefore to reduce caries risk.[12]

The aim of this study was to assess and compare the effect of fluoride and TCP varnishes on salivary and plaque pH among the professional athletes who consume soft drinks. The null hypothesis was that TCP varnish could minimize pH drop in saliva and in inter-proximal plaque.

Materials and methods

In this clinical trial, after approval of the ethics committee of research council of the Dental Faculty, 40 professional athletes (33 males, 7 females) of the Olympic Federation, who signed the informed consent and met the inclusion criteria, participated. The inclusion criteria were: consumption of sweet drinks more than three times daily, age 18 years or older, being cooperative, having no systemic diseases, no periodontal problems, no orthodontic retainers or night guards, not being on antibiotics three weeks before or during

the study, not taking medications affecting salivary secretion and not smoking.

The procedure of the trial was explained to the participants and they were asked not to brush their teeth, apply dental floss or mouthwash two days before the experiment and not to drink or eat two hours before pH measurement. A questioner handed over to the participants who contained questions about the type of sport, type of sweet drinks that each participant consumes and the period of daily workout. The validity and reliability of the questioner has been evaluated in a pilot study.

10ml of unstimulated saliva was extracted with a pipette from each participant, Saliva pH was measured by a pH meter (Hana, model 8321, Italy), which was calibrated each time before the measurement. The inter-proximal plaque pH measurement was done with plaque sampling from the distal surface of the first molar, using a special applicator available in GC plaque indicator kit (GC America, USA) (Figure 1). After cleaning teeth by using gauze, participants were randomly allocated to two groups for application of varnishes: Group 1(n=20): Fluoride varnish (5% NaF, Sultan®, USA), and Group 2 (n=20): Tri-Calcium Phosphate varnish (TCP) (3M®, ESPE, USA). Participants were blinded to the type of varnish to be applied.

Both varnishes were applied as a thin layer on all surfaces of the teeth and occlusal fissures with an applicator and inserted into the interproximal spaces by dental floss. The athletes were asked not to eat for an hour, not brush their teeth after the application of the varnish, not eat hard and sticky foods or hot drinks for two hours, and not to use mouthwash for 24 hours.

After three weeks, the measurement of saliva and plaque pH of the participants was done as mentioned earlier and the respective varnish in each participant was applied once again. Six and twelve weeks after the first visit, pH measurement was repeated without varnish application to evaluate the possible changes during the time. Data were analyzed by a blinded statistician using Repeated Measures ANOVA and P-value set at 0.05.

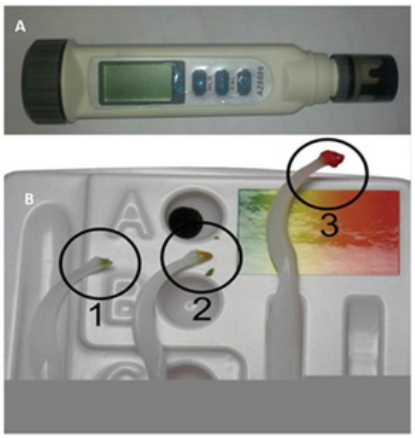

Figure 1 A, Ph meter; B, interproximal; plaque pH examination instrument.

Results

7 of the participants were woman and 33 were man. There were no differences in plaque and salivary pH between the genders. In both groups, there was no significant difference in plaque pH within the time periods (p=0.98) (Table 1). Salivary pH difference was also insignificant in all follow-ups (p=0.068) (Table 2).

Table 1 The mean of plaque pH (SD) in different groups and time periods

	Baseline pH	3rd week	6th week	12th week
Fluoride varnish	6.3(0.25)	6.3(0.30)	6.4(0.20)	6.4(0.23)
TCP varnish	6.3(0.25)	6.3(0.36)	6.4(0.20)	6.5(0.14)

Table 2 The mean saliva pH (and SD) in different groups and time periods

	Baseline pH	3rd week	6th week	12th week
Fluoride varnish	7.0 (0.27)	6.8 (0.45)	6.9 (0.29)	7.0 (0.23)
TCP varnish	6.7 (0.44)	6.8 (0.49)	6.9 (0.21)	6.9 (0.20)

Both varnishes affected the buffering capacity of saliva and plaque pH of the participants who had low pH (less than 5) at baseline (p<0.05) (Figure 2 & 3). As it is shown in Figure 1 in participants with lower baseline plaque pH more improvement occurred at the end. Also salivary pH was raised in participants with lower baseline pH. There was no significant relationship between the questioner items in two study groups (p<0.05).

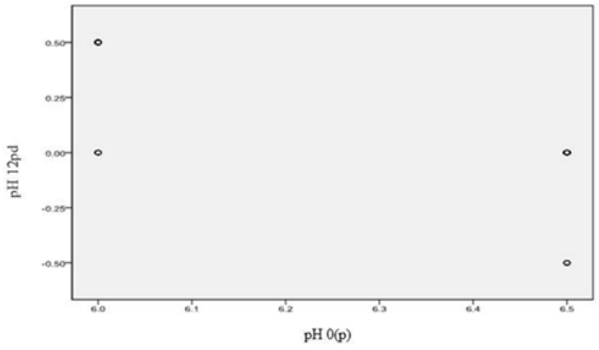

Figure 2 The pH of plaque in the 1st and 12th weeks in patients with low baseline pH.

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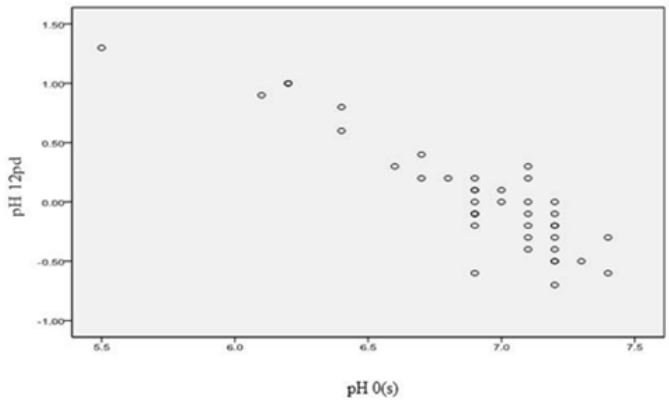

Figure 3 The pH of saliva in the 1st and 12th weeks.

Discussion

Prevention of caries and erosion in individuals with high caries risk is a major goal in public health settings. Professional athletes, due to their physical activities, regular exercise and sweating during their workout, need to drink high-calorie beverages to counteract their dehydration and balance their body electrolytes.[5–7] This could cause pH changes in the oral environment which consequently result in tooth decay and erosion due to the high acidity of the beverages.[5] Several studies have shown that consumption of soft or energy drinks can lead to an increased incidence of dental caries and erosion.[4–7] Hence, proper methods of caries prevention accompanied by remineralizing measures may be beneficial in these groups.

In this study the effect of two materials, fluoride and TCP varnishes, with tooth mineralizing potentials evaluated in professional athletes to decrease the incidence of caries and its consequences especially in the world competitions period. Numerous studies confirm the anti-caries effects of these products.[1516,22,23] It has been shown that fluoride increases the structural strength of the tooth through incorporating the released calcium from hydroxy apatite and subsequent remineralization.[15,16,23] Therefore, it seems that plaque pH might be increased and the remineralization process accelerated.[1,24]

There are controversies in the number of fluoride varnish applications in the literature.[16,22,25] It is recommended to apply the fluoride varnish every three months for high caries risk patients and every six months for those with the low risks.[22] A study have suggested to apply fluoride varnish three times a week for one year as more effective than twice yearly.[20] However, this was not possible to implement in our study because it was difficult to get the athletes to attend the clinic weekly for varnish application. Also an earlier study indicated that application of fluoride varnish once in three months has no effect on interproximal plaque pH.[26] In our current study fluoride varnish was applied every three weeks but even it contained 22,600 ppm fluoride, did not increase the plaque pH in athletes. Another study among the patients under chemotherapy revealed that neither plaque pH nor the amount of saliva changed within 42 days with Fluoride varnish. However, saliva buffering capacity and its pH improved during the test period.[27]

In the current study TCP varnish with 11,300 ppm fluoride did not increase the pH. Our study revealed no difference between the applications of TCP varnish and fluoride varnish. It could be assumed that the positive effects of each varnish have been affected by excessive soft drink consumption by the professional athletes in this study or by limited longevity of the effective biomaterials in the saliva or plaque. Eakle WS et al.[16] showed that the amount of released fluoride reached its baseline after six hours.[16] Karami et al.[17] also concluded that fluoride varnish remained in the saliva for only seven hours.[17] It might be the reason that why in the current study fluoride varnish did not increase the pH values in athletes; despite the manufacturer claims that releasing of calcium, phosphate and fluoride ions from TCP takes up to 24 hours and in clinical conditions the maximum amount of fluoride is released during the first hour.[12] Vogel et al.[28]investigated the impact of chewing normal and TCP-containing gums for 15 minutes after consuming sucrose solution on saliva and plaque composition. The results indicated positive effects of TCP-containing chewing gum on saliva and plaque contents (i.e., calcium and phosphate), but demonstrated lower effects on pH changes. In addition, it was concluded that neither the amount of pH changes after acidity reduction nor their later effective increase was influenced by this substance.[28]

An interesting finding of the current study was the buffering effect of both varnishes in participants with lower baseline pH. It might be useful in the future studies to include only the athletes with saliva pH equal to or lower than 5 to evaluate the buffering potential of different varnishes. Future *In Vitro* and *In Vivo* studies are required to evaluate the higher application frequencies of both varnishes.

It is clear that in high-risk individuals, one application of both varnishes, which is often suggested in books and references, will have no significant impact on saliva and plaque pH. Consistency in the application of varnish seems to be more effective which requires further research to define the frequency of application and the effective intervals.

Conclusion

According to the limitations and circumstances of this research, it can be concluded that none of the varnishes raised the pH of plaque or saliva in professional athletes when applied twice within three weeks. As a supplementary finding, fluoride and TCP varnishes application increased the plaque and saliva pH in athletes with low baseline pH which certainly needs further investigations.

New findings:

a. Varnishes caused changes in plaque and saliva pH in this study.

b. Varnishes showed effective buffering capacity in subjects with low baseline pH.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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