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Short communication

Oral pH and drinking habit during ingestion of a carbonated drink in a group of adolescents with dental erosion

R. Moazzez, B.G.N. Smith, D.W. Bartlett*

Division of Conservative Dentistry, Guy's, King's and St Thomas' School of Dentistry, King's College, London SE1 9RT, UK

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Abstract

Objectives: To investigate the relationship between dental erosion, oral pH and drinking habit in a group of adolescents.

Methods: Oral pH was measured simultaneously at the surface of four teeth in 11 patients, aged 10–16 years, with erosion and in 10 controls subjects without erosion using antimony electrodes. Measurements were made before, during and after drinking 330 ml of a carbonated drink. The method and timing of drinking the beverage, reported dietary intake of acidic foods and flow rate and buffering capacity of saliva were recorded.

Results: The erosion patients reported drinking more carbonated drinks ($p < 0.01$) and drinking directly from a can more frequently than the controls ($p < 0.05$). They also drank twice as quickly ($p < 0.05$). The pH at the buccal surface of a molar remained lower for longer in the erosion patients than in the patients without erosion ($p < 0.01$), whilst the labial surface of the upper central incisor had a longer exposure to low pH in the controls subjects ($p < 0.05$).

Conclusion: The pattern of oral pH differed between subjects with and without erosion after drinking an acidic beverage. This may be related to observed differences in drinking habit, which could have influenced the pattern of erosion in these subjects.

Keywords: Dental erosion; Oral pH; Measurement; Saliva

1. Introduction

The UK national child dental health survey suggested that dental erosion is common in young adolescents and assumed that it was caused predominantly by acidic drinks [1]. The role of dietary acids in dental erosion is acknowledged, but the aetiology in individuals and in groups of patients is often not clear [2,3]. The quantity and quality of the saliva may also be important, perhaps together with variations in the solubility of enamel at different sites in the mouth and between patients [4–6]. Small antimony pH electrodes normally used for measurement of oesophageal reflux have been reported to measure oral pH [4,7,8]. The aim of this study was to compare pH at four sites in the mouth during and after drinking a carbonated cola drink in adolescents with and without erosion. A further aim was to compare the reported drinking habit, dietary acid intake together with the buffering capacity and flow rate of saliva of the two groups.

* Corresponding author. Tel.: + 44-171-955-4937; fax: + 44-171-955-4935.

E-mail address: david.bartlett@kcl.ac.uk (D.W. Bartlett).

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2. Method and materials

All subjects were medically fit and healthy, aged between 10 and 16 years, had a good standard of oral hygiene and a minimum of 20 permanent, caries free teeth. They were attending a community dental clinic and gave informed consent to participation in the investigation, which had ethical approval. The Smith and Knight Index [9] was used to assess the level of wear in all patients. Subjects with dentine exposure were allocated to the erosion group and those without dentine exposure comprised the controls.

The dietary questionnaire was conducted with standard questions asked in a set order. The beverage intake was recorded as the number of cans per week for carbonated drinks and number of glasses per week for fruit juices [3]. This was previously shown to be the most convenient method for estimating the intake in adolescents [3].

Saliva was collected after 15 min rest at least one hour after food or drink. The salivary flow and buffering capacity were measured using the technique previously described by the authors [3,10]. Antimony pH electrodes, commonly used by gastroenterologists to measure oesophageal pH, were positioned flush with the tooth surface by a close

Table 1
Median (interquartile range) of frequency of intake of acidic foods and drinks (items per week) reported by erosion and control groups

	Erosion group $N = 11$	Control group $N = 10$	p Value
Carbonated drinks	14 (14–21)	5 (1–7)	**0.003**
Fruit	4 (2–10)	14 (4–21)	0.063
Fruit juice	1 (0–7)	3 (0–7)	0.942
Orange cordial or squash	3 (2–4)	0.5 (0–5)	0.246
Sport drink	1 (0–2)	0 (0–0)	**0.028**
Acidic crisps	1 (0–10)	0 (0–0)	**0.036**

Table 2
Median (interquartile range) unstimulated and stimulated salivary flow rate (minutes) and buffering power (final pH) in erosion and control groups

	Erosion group	Control group	p Value[a]
Unstimulated saliva flow rate (ml/min)	3.6 (2.7–5.4)	3.3 (2.9–5.5)	0.916
Stimulated saliva flow rate (ml/min)	2.1 (1.1–2.7)	2.25 (1.8–2.5)	0.501
Buffering capacity of unstimulated saliva (ml/min)	4.5 (4.0–5.0)	5.0 (4.5–5.0)	0.273
Buffering capacity of stimulated saliva (ml/min)	5.0 (5.0–6.5)	5.5 (5.0–6.3)	0.914

[a] Mann–Whitney *U*-test.

fitting, custom made, vacuum formed appliance. Subjects were given 20 min at the start of the study to accommodate to the plastic appliance. They then drank a carbonated beverage (pH 2.45 and titratable acidity of 0.29 ml with 0.05 M NaOH) in their normal manner (either from a can or a glass) and then relaxed for a further 10 min. The pH at the tooth surface was analysed for the percentage time that the pH fell below 5.5 and 4 during these periods, using previously reported methods [8]. The data were not normally distributed and non-parametric statistical tests were used.

3. Results

The erosion group comprised 8 males and 3 females (median age 13 years, interquartile range 12–14) and control group 3 males and 7 females (11.5 years, 11–14.5). Table 1 shows that the consumption of carbonated drinks, sports drinks and acidic crisps was higher in the erosion patients ($p < 0.05$). Drinking from a can was more common in the erosion group with 10 subjects using this technique whilst, in the control group 4 used a can and 6 used a glass (Fisher's exact test, $p < 0.05$). Table 2 shows the median (interquartile ranges) for salivary flow rates and the salivary buffering capacity (final pH) of the unstimulated and stimulated saliva. No statistically significant differences were observed between the groups. The erosion patients took a median 4 min (interquartile range = 4–7) to finish their drink and the controls took 8 min (6–11.3) and this difference reached statistical significance ($p < 0.05$). Table 3 shows the median and interquartile range for the percentage time that the pH fell below 5.5 and 4. The pH fell below 5.5 and 4 for a greater proportion of the time on the buccal surface of the upper molar in the erosion patients than the controls ($p < 0.05$). The reverse was true on the labial surface of the central incisor with the pH staying low for longer in the control subjects ($p < 0.05$). There were no statistically significant differences between the pH on the palatal surface of the upper molar or incisor.

4. Discussion

This preliminary study suggests that the speed and manner in which a carbonated beverage is consumed may be related to different distributions of acid in the mouth. The findings complement previously published work, which indicated difference in the distribution of fluid during

Table 3
Median (interquartile range) of percentage time that pH fell below 5.5 and 4 at tooth surfaces in erosion and control groups

	Tooth surface	Erosion group	Control group	p Value[a]
Percentage time below pH 5.5	Buccal surface of upper right first molar	7.0 (4.2–19.7)	1.4 (0.4–5.6)	**0.010**
	Labial surface of upper right incisor	33.6 (26.7–52.4)	46.1 (38.3–80.6)	**0.035**
	Palatal surface of upper left first molar	25.3 (16.1–41.4)	20.1 (4.1–35.8)	0.526
	Palatal surface of upper left incisor	20.6 (14.1–28.6)	23.0 (10.6–26.1)	0.573
Percentage time below pH 4	Buccal surface of upper right first molar	3.0 (3.0–4.3)	0.0 (0.0–0.0)	**0.002**
	Labial surface of upper right incisor	20.3 (17.7–28.1)	34.4 (27.8–42.2)	**0.024**
	Palatal surface of upper left first molar	12.1 (5.9–17.0)	7.0 (5.5–17.5)	0.102
	Palatal surface of upper left incisor	15.9 (10.3-21.7)	13.5 (4.8–25.0)	0.970

[a] Mann–Whitney *U*-test.

drinking with or without a straw [11]. Although the number of subjects limits this study, the results provide sufficient evidence to warrant further investigation of the relationship between consumption of carbonated drinks and the role of drinking habits in erosion.

Continuous measurement of pH indicated that an acid beverage was quickly buffered in the mouth of all subjects within minutes, and returned to salivary levels rapidly once the drink was finished, in agreement with the findings of Millward et al. [7]. Despite this, the patients with erosion demonstrated a longer period of time at low pH on the buccal surface of a molar following drinking of a carbonated drink, whilst the controls showed longer exposure to low pH on the labial surfaces of the upper incisor. These results may reflect the differences observed between the groups in method and speed of drinking the carbonated beverage. It is probable that pH at the labial surface is directly affected by the time taken to consume the beverage, whilst longer periods of low pH on buccal surfaces of the posterior region may indicate that erosion patients retain the drink in the mouth for longer periods. Combined with their reported higher consumption of acidic drinks, this may place them at a greater risk of developing erosion.

The results from the saliva analysis suggest that salivary characteristics are not overtly associated with erosion. These findings are in agreement with Bartlett et al. [3] in adolescents and Gudmundsson et al. [4] in adults. However, in the present study, as in many other studies, saliva was collected on only one occasion and at different times of the day. The effect of the different times of collection may not have had a major effect on the results, as some reports have suggested that these parameters remain relatively constant outside meal times [12]. Milosevic [6] has reported differences in the salivary parameters in the children with and without erosion, and further studies with more control of circadian rhythm and larger numbers of subjects are warranted.

In conclusion, this study does not suggest a single cause for erosion in these subjects. However, the erosion patients reported drinking more carbonated drinks and the method and speed of drinking was significantly different between the two groups. These factors may have influenced the level and pattern of erosion in these subjects. The results suggest that, in future, health promotion may need to be directed towards modifying drinking habit as well as frequency of intake of acidic drinks to prevent erosion.

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