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Original Article

The Effect of Carbonated Drinks on Etched Enamel- A SEM study

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ABSTRACT

Background: The purpose of this study was to evaluate the effect of carbonated soft drinks, on the etched enamel of extracted teeth in a simulated oral environment. The teeth were then compared for amount of enamel erosion with another set of teeth that were immersed in cow milk and distilled water. The resultant values were then compared to see which solution (carbonated drink, cow milk or distilled water) caused more amount of enamel erosion.

Methods: Soft drinks were tested on 150 extracted human teeth. The teeth were divided into three groups with 50 teeth in each group. Teeth under control group A were not etched. Teeth in the first and second experimental groups were etched with 37% phosphoric acid. Teeth in the control group were immersed into distilled water. Teeth in the first experimental group were immersed into cow milk and the second experimental group under mixture of artificial saliva and carbonated drink. The teeth were soaked into the test solution for 72 hours. The labelled teeth were sent under three separate groups for testing under scanning electron microscope (SEM).

Results: Teeth immersed into the carbonated drink underwent the most amount of erosion followed by Teeth immersed into cow milk, while the teeth immersed into distilled water showed negligible amount of enamel erosion.

Conclusion: The study concluded that enamel erosion was directly proportional to a fall in the ph of the test solution. Carbonated drink solution was the most acidic as compared to milk and distilled water.

Keywords: carbonated drinks, enamel erosion, etched enamel, orthodontics, teeth.

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Introduction

In recent years there has been increased interest in the role of commercial soft drinks in dental diseases such as dental erosion.[1] Erosion can be classified as extrinsic (diet based) or intrinsic (gastro-oesophageal) in origin.[2] This study successfully shows that the lesser the ph of the solution the greater was the loss of enamel material from the tooth. Thus there is a need to create awareness regarding the detrimental effects of carbonated drinks on oral health. Youngsters and school going children must be made as the specific targets and dentists should educate the public about the possible harm that human teeth have to endure from the consumption of carbonated drinks.

Erosion is typically progressive and results in the wearing away of the exposed tooth surface (enamel or root surface).[3,4,5] Continuous evolution and experimentations with food and beverages have caused a plethora of changes in our staple diet.[6] Contemporary changes include shift in the types and quantities of beverages consumed, the manner in which they are consumed and their role in the diet. Most notable, is the decrease in the intake of milk and increased consumption of carbonated and non-carbonated soft drinks.[7]

Nutrient profiles of these beverages differ and most of these soft drinks have a pH in the range of 2- 6. Less recognized, however, are the implications that changes in beverage consumption can have for oral cavity. Oral bacteria ferment carbohydrates and produce acids. The inherent acids have acidogenic potential, resulting in potential enamel erosion.

Dental erosion (erosive tooth wear) is the situation of a chronic loss of dental hard tissue that is chemically etched away from the tooth surface by acid and/or chelation without bacterial involvement. These acids can be from diet through the ingestion of food and beverages, or from stomach acids when they reverse course and travel through the oesophagus to the mouth. This leads to a significant impact on patients' oral health by creating loss of tooth structure, tooth sensitivity and changes in the appearance of teeth.[8] The pattern of erosion is related to how frequent the dental tissue is exposed to acidic fluid. Many studies have showed a positive relationship between dental erosion and the consumption of soft drinks.

Acids present in wine, soft drinks, sports drinks and fruit juices, can dissolve calcium and phosphate from the enamel, leading to tooth demineralisation and tooth erosion. Continued erosion, and exposure of dentin underneath, causes tooth sensitivity to temperature changes and touch during brushing.[9]

Materials and Methods

A carbonated drink, cow milk and distilled water were tested on 150 non-carious, non- fluorosed extracted human incisors, canines and premolars. Incisors and canines were collected from patients of 45-60 years of age who had undergone extraction of these teeth. Premolar teeth were collected from patients aged between 18-25 years requiring extraction of these teeth due to orthodontic treatment. All the teeth were proportional divided in the 3 groups so as to have a group matching based on the criteria of teeth selected. We measured the pH and the percentage of weight loss.

The teeth were divided into three groups (one control and two experimental groups) with 50 teeth in each group. The groups were named as Group A, Group B and Group C. Teeth under control group (Group A) were not acid etched. Teeth in the first experimental group (Group B) and in the second experimental group (Group C) were etched with 37% phosphoric acid.

Teeth in the control group ***(Group A)*** were immersed into distilled water. Teeth in the first experimental group ***(Group B)*** were

immersed into artificial saliva + bovine milk. Teeth in the second experimental group ***(Group C)*** were immersed into a mixture of artificial saliva and carbonated drink, the teeth were labelled with a water proof marking pen, then soaked into the respective test solutions for 72 hours. The solutions were changed after every 24 hours to ensure that they were fresh. The labelled teeth were sent under the above mentioned groups ***(Group A, Group B and Group C)*** to be studied histologically under electron microscope.

After labelled teeth reached lab, the teeth were cleaned and washed with distilled water and dried with air spray, and a cross section was made by cutting from the occlusal side to the cervical area and Observed under microscope and Photograph taken. Statistical analysis was performed using two factor ANOVA. Analysis was performed using SPSS software version 20.

Results

Results were obtained following the electron microscopy and it was found that enamel loss was the most with those teeth which were immersed into a mixture of artificial saliva and carbonated drink ***(Group C).***

Lesser amount of enamel loss was reported from the teeth which were immersed in the solution containing a mixture of artificial saliva and bovine milk, which was attributed to the formation of lactic acid over time ***(Group B).***

The amount of enamel loss was almost negligible of those teeth immersed into distilled water ***(Group A).***

Table 1: Comparison of Group B and Group C

Group	pH	Titratable acidity at 5.5 (ml)	Titratable acidity at 7.0 (ml)	p value	% weight loss after 6 hours	% weight loss after 24 hours	p value
Group C	3.38 ± 0.30	2.30 ± 1.97	3.02 ± 3.57	< .05*	1.80 ± 0.55	6.17 ± 3.60	< .05*
Group B	2.84 ± 0.18	1.06 ± 0.73	1.74 ± 1.37		3.20 ± 0.93	12.4 ± 3.77	

* significant

Electron microscopic images

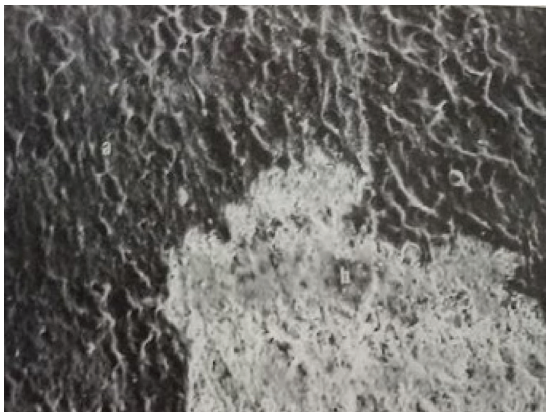

Figure 1: Etched tooth surface exposed to cow milk

Figure 2: Tooth immersed in distilled water

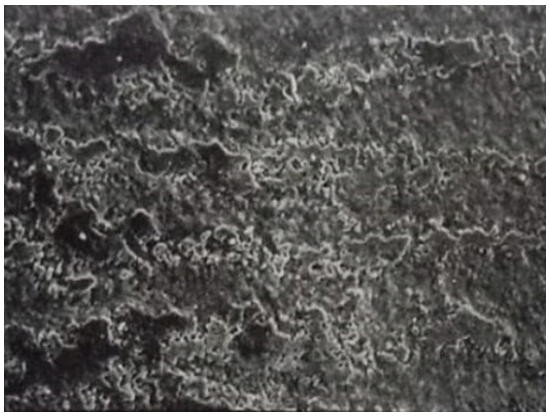

Figure 3a: Etched tooth in carbonated drink

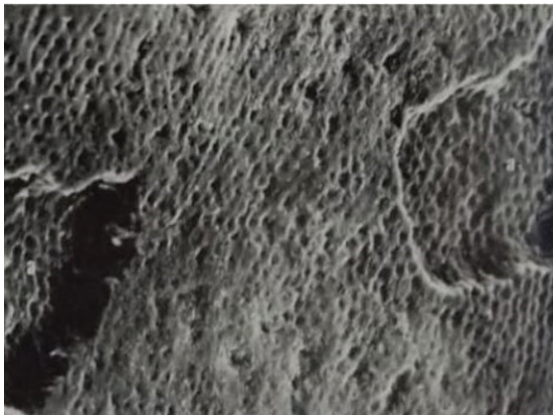

Figure 3b: Magnified image showing large areas of erosion

Discussion

Previous studies indicate that carbonated soft drinks may cause significant long term enamel dissolution. Carbonated beverages were markedly more aggressive towards enamel than coffee or tea.

Atomic absorption results suggest that the increasing weight loss in tooth enamel during dental erosion in soft drinks can be attributed to the continuous leaching of Calcium ions, in addition to phosphorus, oxygen and hydrogen.[10] In order for enamel erosion to occur by soft drinks the ph value should be less than **5.5**.[11] This is known as the critical ph value required for enamel demineralization to occur.

Dental erosion seems to have much stronger relationship with soft drinks. The erosive potential of drinks is mainly represented by their pH and the buffering capacity. In previous reports, the initial pH values of some soft drinks and their buffering capacities were determined. Carbonated drinks had lower pH than fruit juices.[12] The buffering capacities are in the following order: fruit juices>fruit-based carbonated drinks .[12,6]

More studies showed that dental erosion was associated with the drinking methods. Holding the drink longer in the mouth leads to a more pronounced pH drop.[13] Drinking with an increasing flow rate and with decreasing outlet diameter could increase drinks>non-fruit-based carbonated drinks, the erosion depth.[14] The effect is also strengthened when acid temperature grows higher .[15]

Most soft drinks contain acidulants such as phosphoric acid and citric acid, along with varying amounts of malic, tartaric, and other organic acids. These polybasic acids exhibit buffering capacity and can maintain the local pH at the tooth surface below the threshold value even with marked dilution; as a result, they can be very aggressive toward dental enamel. The presence of these polybasic acids in beverages is important, as their ability to chelate calcium at higher pH levels could cause significant enamel dissolution through a calcium chelation effect rather than a simple acid attack.

Scanning electron microscopy (SEM) studies in the past have shown that the decrease in ph of the solution brings about a greater loss of enamel material.[5]

During orthodontic treatment with fixed appliances, frequent intake of carbonated water could increase the risk of erosion of enamel around the brackets. Erosion of enamel around the brackets, which had

been etched for bonding,[16,17] could cause dental caries and decrease the retention of the appliances. Even though the etched enamel had been sealed with adhesive material, carbonated water could strip off the adhesive and reveal the etched enamel. Therefore, clinicians should instruct orthodontic patients that carbonated water has negative effects on teeth, especially those with fixed appliances.

Carbonated water has negative, destructive effects on teeth, and result in decreasing micro-hardness and removal of the adhesive material on etched or sealed enamel. Erosion occurred when the etched enamel of teeth was exposed to carbonated water, particularly in groups exposed to high-level carbonated water. Alleviation of this destructive effect is observed in groups exposed to carbonated water with calcium ion. Partial removal of the adhesive material on sealed enamel could be observed after exposure to carbonated water.[18]

Conclusion

The study successfully showed that enamel erosion was directly proportional to a fall in the ph of the test solution. Carbonated drink solution was the most acidic as compared to milk and distilled water. Thus a need to create awareness regarding the detrimental effects of carbonated drinks must be created. Youngsters, school going children must be made as the specific targets and dentists should educate the public about the possible harm that human teeth have to endure from the consumption of carbonated drinks.

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