Abstract

Dietary awareness is an important issue in modern society. The consumption of carbonated beverages is popular with the youth of today and the habit is carried over into adulthood. With the frequent consumption of acidic drinks, dentitions of children are at a higher risk for acidic demineralization, ultimately leading to dental erosion. These altered habits have to be taken into account when considering the augmented dental erosion status. The type of beverages and foods that we consume daily and the frequency of intake have a major influence on the severity of damage caused to the dental enamel. Patients with erosive tooth wear are usually oblivious to the deleterious effects of carbonated beverages. Therefore a comprehensive knowledge of the various risk factors involved in the causation of dental erosion, by a dental professional is imperative. This review is in fact an attempt to appraise the readers regarding soft drinks induced dental erosion so that adequate preventive measures and treatment procedures can be initiated.

Keywords: Soft Drinks; Dental Enamel; Tooth Erosion; Review

Introduction

It has been reported that fluid consumption patterns of children are now more diverse than in the past years since carbonated beverages including soft drinks have replaced much of the previous consumption of water and milk among children [1,2]. Frequent and excessive consumption of specific dietary elements such as citrus fruits, lemon juice, orange juice, fruit squashes, cola-flavoured soft drinks and citrus-flavoured drinks have all been implicated as risk factors for dental erosion. Unusual eating, drinking and swallowing habits, such as holding an acidic beverage in the mouth before swallowing, increases the contact time of an acidic substance with the teeth thereby increasing the risk of dental erosion [3].

Dental erosion is the chronic loss of dental hard tissue by means of chemical wearing of the tooth surface by acid without bacterial involvement. Acids responsible for the causation of dental erosion are either of intrinsic or extrinsic origin [4]. Intrinsic sources of acids originate in the stomach and are associated with eating disorders, such as anorexia and bulimia nervosa, or with acid reflux and regurgitation. Extrinsic sources are acids contained in dietary components, such as carbonated soft drinks, citrus fruit and fruit juices [5]. Most people view soft drink consumption as fairly innocuous; however, there are many seriously health related issues associated with frequent consumption of soft drinks. Various epidemiological studies done worldwide have shown a positive association between excessive soft-drink consumption and high prevalence of dental erosion [6,7]. Reports show that erosion of teeth due to soft drinks consumption is likely to be influenced by the temperature of the beverages. Eisenburger and Addy observed that erosion depth increased significantly with acidic pH at high temperature. Acidic beverages that are cooled before their consumption tend to reduce their erosive effect [8].

Multi-Factorial Etiology of Dental Erosion

Dental erosion is a multi-factorial disease. Various risk factors responsible for the causation of dental erosion are broadly classified into patient related factors and nutritional factors. Patient related factors include chemical, biological and lifestyle factors whereas nutritional factors include pattern of consumption constituting, drinking habits and frequency of consumption.

Some individuals exhibit more erosion than others, even if they are exposed to exactly the same acidic challenge in their diets. This may be explained on the basis of interplay of various causative factors.

Chemical Factors

Susceptibility towards dental erosion varies among individuals as it is not exclusively dependant on pH but also upon their mineral content, buffering capacity, and calcium-chelating properties [9]. The pH value, calcium and fluoride content of soft drinks determine the degree of mineral saturation with respect to the tooth surface, which is the driving force for erosion. Soft drinks, which tend to be carbonated, have a low pH and contain phosphoric acid and a variety of other additives which may submit dental enamel to dental erosion [10,11]. Fruit juices and fruit based carbonated drinks have increased buffering capacity which may induce a prolonged drop in oral pH predisposing dental enamel to the risk of dental erosion [12]. Lussi and Jaeggi observed that saliva takes longer time to neutralize the acids produced by soft drinks with higher buffering capacity. Higher buffering capacity of a soft drink will enhance the
processes of dissolution as more ions from the tooth surface are needed to render the acid inactive for further demineralization [13]. It has been reported that certain drinks such as carbonated soft drinks are retained on dental enamel and are less likely than other beverages to be removed by saliva, resulting in an increased acidogenicity [14]. Due to significant differences in the ability of various soft drinks to adhere to enamel it is preferable to consume drinks with a lower ability because they are more easily displaced by saliva [15].

A study was conducted to assess the erosive potential of drinks on the Icelandic market. The study showed that citrus fruit juices (grapefruit and orange juice) needed the most amounts of bases to neutralize the beverages tested. The milk-based beverages had an initial pH above 5.5 and are, therefore, non-erosive, with the exception of milk-derived lactic acid and drinks containing lactic acid. Carbonated drinks, sport drinks and energy drinks were relatively easy to neutralize, despite having a lower pH than fruit drinks, hence it was concluded that many soft drinks have a considerable erosive potential and several of these are particularly targeted at the age groups found in other Icelandic studies to consume large amounts of soft drinks and to have tooth erosion [16].

The underlying acidity of beverages is believed to be the primary factor in the development of dental erosion; this total acid level (known as titratable acid), rather than the pH, is thought to be an important factor in erosion because it determines the actual hydrogen ion availability for interaction with the tooth surface [17,18].

**Behavioral Factors**

**Drinking Habits and Pattern of Consumption**

The individual manner of drinking acidic soft drinks has long been thought to influence the pattern of tooth destruction, depending on how long the teeth are in contact with the erosive challenge [17]. The drinking method strongly affects the tooth-surface pH and thereby the risk for dental erosion.

In a study, six different methods of drinking were tested in a randomized order by: holding; short-sipping; long-sipping; gulping; nipping; and sucking. Holding the drink in the mouth before swallowing led to the most pronounced pH drop, followed by the long-sipping method. Gulping resulted in only a small decrease of pH [19,20]. Rapid erosion is seen when erosive drinks are consumed from a straw placed labial to the anterior teeth, or are “swished” between the teeth. Edwards and coworkers recommended that drinking through a straw positioned toward the back of the mouth may reduce the erosive potential of soft drinks. Highess reported an unusual case of a 12 year old boy who drank 2-4 litres of cola beverages every day. Dentition of the boy depicted widespread enamel loss due to habit of holding a cola drink in his mouth until all the dissolved gas had dissipated [21].

O’Sullivan and colleagues conducted a case control study in 309 children. It was concluded that children with dental erosion consumed more carbonated beverages than their controls. The swishing and holding habit found in 43% of the subjects was also noted as an aggravating factor for dental erosion [22]. On the other hand, Smith and Shaw considered the mode of intake of acidic beverages to be of less importance than the frequency since the pH of the tooth surface requires at least five minutes in order returning to its resting level after dropping [23].

**Frequency of Consumption**

The frequency of soft drink consumption is an important factor in dental erosion. Typically, soft drinks consumed at meal times are less injurious than those consumed alone. Continuous sipping is considered more harmful to dentition than consuming an entire beverage at once [24]. In children dental health survey in United Kingdom it was found that there was a trend towards a higher prevalence of erosion in children aged between 3½ and 4½ years; and in those who consumed carbonated drinks on most days, compared with toddlers consuming these drinks less often [25].

Von Fraunhofer and Rogers conducted an in vitro study in which enamel blocks were sectioned from sound extracted human premolars and molars. They were measured, weighed, and immersed in the selected beverages for a total of 14 days. Enamel dissolution occurred in all of the tested beverages, with far greater attack occurring in flavoured and energy drinks than for water and cola-flavoured drinks. It was concluded that reduced residence times of beverages in the mouth by salivary clearance or rinsing appear to be beneficial for the dentition [26]. Johansson et al. conducted a study on Saudi men with dental erosion. The results showed that higher intake of cola-flavoured drinks were more common in the high than in the low-erosion group. High erosion was associated with a method of drinking whereby the drink was kept in the mouth for a longer period, pH after drinking did not differ between the groups for any of the six measuring sites. Hence it was concluded that consumption of cola-flavoured drinks and its method of drinking are the factors associated with dental erosion [27].

**Lifestyle Factors**

Many people today are in constant pursuit of ‘healthier’ lifestyles involving regular exercise and healthy diet. Exercise increases the loss of body fluids leading to dehydration and reduced salivary flow. Intake of energy drinks with low-pH during a time of decreased salivary flow enhances their destructive effect thereby resulting in dental erosion. [28]

The dry mouth combined with dehydration from vigorous exercise and excessive consumption of low pH energy drinks has also been linked to dental erosion. Dieting has also been considered a
potentially important contributor to the etiology of dental erosion. It is known that high consumption of fruits and fruit juices may be part of many individuals’ weight reduction plans. A study carried out in 1,949 children aged 3-5 years in China, showed erosion on primary maxillary incisors (5.7%). A significantly higher prevalence of erosion was observed in children who had frequently consumed fruit drinks as a baby and whose parents had a higher education level. The presence of calculus or eating fruit other than apples or citrus fruit reduced the chances of erosion. High consumption of carbonated drinks increased the odds of erosion by 25.2% [29].

A Swedish study noted that “individuals” undergoing fasting for health reasons frequently consumed herbal teas, were found to be very acidic with a relatively high buffering capacity and low fluoride concentration [30]. The investigators suggested that the combination of acidic drink consumption and reduced salivary flow associated with fasting may increase the risk of dental erosion.

**Biological Factors**

Saliva is essential for the maintenance of oral health and decreased salivary flow causes a clinically significant oral imbalance. Furthermore, diminished saliva production reduces the capacity to clear and neutralize dietary acids in the mouth contributing to erosive lesions in some individuals [31]. Järvinen et al. found a low stimulated salivary flow in sixteen erosion cases and six controls, while a reduction in unstimulated flow was seen in seven cases and six controls. Significantly more erosive lesions were registered in individuals with low salivary flow rates than in subjects with higher flow rates. Patients with a salivary flow rate of ≤ 1 ml/min were at a five-time greater risk of developing dental erosions than those with higher flow rates [32].

Several salivary protective mechanisms also come into play during an erosive challenge: dilution and clearance of an erosive agent from the mouth, neutralization and the buffering of acids, which

<table>
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<th>S.No.</th>
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<td>1.</td>
<td>V.K. Jarvinen, I.I. Rytomaa and O.P. Heinonen, 1991</td>
<td>106 cases with erosion and 100 randomly selected controls</td>
<td>There was considerable risk of erosion when soft drinks were drunk daily (odds ratio=4) or sport drinks were drunk weekly (odds ratio=4).</td>
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<td>2.</td>
<td>Ibrahim Al-Majed, Anne Maguire and John J. Murray, 2002</td>
<td>354 boys aged 5–6 years, and 862 boys aged 12–14 years.</td>
<td>1) Pronounced dental erosion was observed in 34% of 5–6 year olds and 26% of 12–14 year olds who frequently consumed carbonated soft drinks at night.</td>
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<td>3.</td>
<td>V. Sirimaharaj, L. Brearley Messer, MV Morgan, 2002</td>
<td>690 members of the University of Melbourne.</td>
<td>The consumption of acidic foods and drinks was frequent among most athletes resulting in 37.4% dental erosion.</td>
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<td>4.</td>
<td>C. R. Dugmore and W. P. Rock, 2004</td>
<td>A random sample of 1,753 children was examined at age 12 and 1,308 of the same children were re-examined at age 14 years.</td>
<td>1) At age 12 significant positive associations were found between erosion and decay experience (odds ratio (OR)=1.48), drinking fruit juice (OR=1.42) or fizzy pop (OR = 1.59-2.52, depending on amount and frequency. 3) High consumption of carbonated drinks increased the odds of erosion being present at 12 years by 25.2% and was a strong predictor of the amount of erosion found at age 14.</td>
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<td>5.</td>
<td>T. Attin, K. Weiss, K. Becker, W. Buchalla, A. Wiegand, 2005</td>
<td>144 bovine incisors one enamel sample</td>
<td>1) significant enamel loss was recorded for the samples rinsed withoriginal Sprite and original orange juice.</td>
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<td>6.</td>
<td>WK Seow, KM Thong, 2005</td>
<td>The beverages were tested for their individual pH.</td>
<td>1) The Vickers Hardness of enamel was reduced byabout 50% in the case of lime juice and 24% in the case of Coca-cola. 2) The most acidic drinks had the greatest erosive effects on enamel.</td>
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<td>7.</td>
<td>M.E. Barbourea,b, M. Finkec, D.M. Parkerc, J.A. Hughesa, G.C. Allenb, M. Addya, 2006</td>
<td>In vitro study using enamel specimens immersed in different drinks.</td>
<td>1) For one drink (Robinson’s Originale Juice Drink), there was a statistically significant increase in dental erosion whereas other drink (Ribena ToothKinde Juice Drink) had no statistically significant impact on erosion.</td>
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<td>8.</td>
<td>S. Wongkhantee, V. Patanapiradej, C. Maneenut, D. Tantbioj, 2006</td>
<td>10 enamel specimens were immersed in e food or drinks.</td>
<td>Significant softening of enamel surface was reported by immersion in orange juice and a sports drink.</td>
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<td>9.</td>
<td>Agneta Hasselkvist, 2007</td>
<td>401 individuals aged 5-6 (n=87), 13-14 (n=157) and 18-19 years (n=157).</td>
<td>Soft drink consumption was significantly higher in individuals with severe dental erosion.</td>
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slow down the rate of enamel dissolution through the common ion effect by salivary calcium and phosphate and involvement in the formation of the pellicle [33].

Conclusion

The modern lifestyle has changed the developmental pattern of certain oral diseases, including dental erosion. Lifestyle factors such as the types of foods and beverages consumed individual susceptibility, the frequency and time of consumption and oral hygiene practices are considered the most important factors influencing the clinical development of dental erosion. The growing consumption of carbonated beverages, including soft drinks has been associated with the increased prevalence of dental erosion. Early erosive damage to the teeth may compromise the entire dentition for lifetime. Hence, timely clinical detection followed by extensive restorative procedures for erosive lesions are recommended by a dental professional. Individuals who are at high risk for dental erosion and for those with active erosive lesions we would recommend that:

1. Reduce acid exposure of dentition by reducing the frequency as well as contact time of carbonated beverages, including soft drinks.
2. Do not hold or swish acidic drinks in your mouth.
3. Avoid tooth brushing immediately before an erosive challenge, as the acquired pellicle provides protection against erosion.
4. Consider using modified acid beverages with no or reduced erosive potential.
5. After acidic beverages intake, stimulate saliva flow with chewing gum or lozenges.

References

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