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# THE DETERMINANTS AND CONTROL OF SOFT DRINKS-INCITED DENTAL EROSION

*Determinantes e controle da erosão dental induzida por refrigerantes*

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## Abstract

**OBJECTIVE**: The aim of this paper has been to review the past and current literature on the determinants and control of soft drinks-incited dental erosion. **METHODS**: The authors used Medline to find relevant literature published until March 2009. Abstracts and full articles were read to identify studies and reviews describing various modifying factors and determinants of dental erosion. Additional information was obtained using manual library search. **RESULTS AND CONCLUSION**: Excessive exposure to various acid sources can contribute to the chemical erosion of tooth surfaces. While these acid sources have the potential to erode teeth, various chemical, biological and behavioral factors determines the erosive action of the acids they contain. Several interceptive and preventive means have been proposed to minimize damage to the dentition.

**Keywords**: Dental erosion. Acidic drinks. Modifying factors. Treatment.

## *Resumo*

***OBJETIVOS**: O objetivo deste artigo foi revisar a literatura passada e atual sobre os determinantes e controle da erosão dentária induzida por refrigerantes. **MÉTODO**: Os autores utilizaram o MEDLINE para encontrar literatura relevante publicada até março de 2009. Resumos e artigos completos foram lidos para identificar estudos e revisões descrevendo vários fatores modificantes e determinantes da erosão dentária. Obteve-se informação adicional pela busca manual na literatura em bibliotecas. **RESULTADOS E CONCLUSÕES**: Exposição excessiva a várias fontes ácidas podem contribuir para a erosão química de várias superfícies dentárias. Enquanto estas fontes ácidas têm o potencial de erosionar dentes, vários fatores químicos, biológicos e comportamentais determinam a ação erosiva dos ácidos que contêm. Várias medidas preventivas e interceptivas têm sido propostas para diminuir os danos causados pela erosão.*

***Palavras-chave**: Erosão dentária. Bebidas ácidas. Refrigerantes. Tratamento.*

## INTRODUCTION

Dental erosion has been reported to be a growing health problem (1, 2) possibly accounted for by the monumental increase in the consumption of soft drinks, fruit juices and sport drinks in the UK, US and many other countries(3). Erosion is the chemical dissolution of the surface of dental hard tissues by acids without the involvement of microorganisms (4). Its process can lead to reduction in size of teeth and depending upon the severity and length of exposure, may lead to the total destruction of the dentition (5). For the first time, England included the evaluation of tooth erosion in its national dental health survey in 1993, indicating the importance of this dental problem (6).

Causative factors for tooth erosion are divided into extrinsic and intrinsic categories. Intrinsic erosion occurs from involuntary gastrointestinal disturbances such as gastroesophageal reflux disease (GERD) and from voluntary regurgitation of gastric acids exhibited by anorexic and/ or bulimic individuals.

Extrinsic tooth erosion causes include environmental factors, medicaments, lifestyle, and diet (7, 8). In modern societies the extrinsic factor is becoming more important, due to the increased consumption of acid drinks as soft drinks, sport drinks, fruit juices and fruit teas (9).

Epidemiological studies shown in Table 1 reported a link between excessive sof-drink consumption and high prevalence of dental erosion (10-16).

TABLE 1 - Epidemiological studies showing a link between excessive soft-drink consumption and dental erosion

| STUDY | TYPE | POPULATION | RESULTS |
|---|---|---|---|
| Moazzez *et al.*(10) | Comparison study | 11 cases witherosion, ten controls aged ten -16 years | Positive association between reported consumption of carbonated drinks and dentalerosion |
| Johansson *et al.*(11) | Comparisonstudy | 19 persons withhigh vs.19 withlow erosion | Positive association between erosion and soft-drink consumption |

In vitro studies shown in Table 2 have shown that soft drinks with low pH can cause erosion in permanent and deciduous teeth.

TABLE 2 - In vitro studies showing a link between soft drinks with low pH and dental erosion in permanent and deciduous teeth

| STUDY | TYPE | RESULT | COMMENT |
|---|---|---|---|
| Larsen MJ (12) | In vitro | Inverse association between pH ofdrinks and calcium fluoride dissolvedfrom the tooth and erosion. Highfluoride concentration had limitedeffect on erosion | Permanent human teeth |
| Larsen MJ (13) | In vitro | Inverse association between pH of drink and solubility of enamel apatite. High buffering effect associated with greater erosion. Positive association with calcium and phosphorus and enamel erosion | Permanent human teeth |
| Hughes JA (14) | In vitro | Inverse association with pH and erosion. Less erosion with increase calcium content | Permanent human teeth |
| Hughes JA (15) | In vitro | No enamel erosion with water,increased erosion with drinks ofdecreasing pH | Randomized, placebocontrolled, crossoverstudy, with water ascontrol, with 54 human teeth |
| Grando LJ (16) | In vitro | Enamel erosion seen with lemon juice,and sugar containing, carbonatedbeverages with and without caffeine | 108 deciduous teeth in three groups |

Most people view soft drink consumption as fairly innocuous and its consumption is not as harmless as generally believed; however, there are a number of serious health issues associated with regular consumption of soft drinks. One peer-reviewed study has reported 25 separate harmful effects associated with the consumption of carbonated soft drinks (17). This review presents current perspectives about the determinants of soft drinks incited dental erosion.

## Preview of different factors

Erosive capacity of different drinks, juices and foodstuffs was said to be statistically significantly associated with their acidity, pH values, phosphate and fluoride contents as well as the baseline surface microhardness or iodide permeability values of the exposed enamel (18). Other factors such as type of acid, pKa, titratable acidity, buffering capacity, and temperature influence the dental erosive capacity of acidic liquids (15). The acidic properties of acids are also determined by the amount of acid available (the titratable acidity) and the amount of acid actually present (concentration of H+ ions-pKa), and all these chemical factors contribute to the erosive potential of a specific acid (19).

Drinks with higher pH, lower titratable acidity, and higher concentrations of calcium, phosphate, and fluoride will have reduced erosive potential (20). The risk of erosion also bore a strong relationship to the amount and frequency of carbonated drink consumption (21). During and after an erosive challenge, behavioral factors play a role in modifying the extent of erosive tooth wear. The manner that dietary acids are introduced into the mouth (gulping, sipping, use of a straw) will affect how long the teeth are in contact with the erosive challenge, therefore, the frequency and duration of exposure to an erosive agent is of paramount importance (22).

## Chemical factors

Of greatest importance are the pH, titratable acidity, acid type, phosphate and calcium concentration, fluoride content of the erosive challenge which determines the degree of saturation with respect to the tooth mineral, and thus the driving force for its dissolution. In an in vitro study to look at the effects of pH and concentration of citric, malic and lactic acids on enamel, numerical data and contour plots for each acid showed a similar pattern for increasing erosion with decreasing pH and increasing acid concentration and vice versa for decreasing erosion (23). The erosive capacity of fruit juices and beverages has been suggested to have a relationship with their pH. However, these workers observed that a strict relation between free hydrogen ions ($H^+$) and demineralizing action was not found, probably due to the influence of other factors not considered the study (24). Beverages with the greatest erosive effects on enamel were said to be the most acidic (1). Conversely, an in vitro study by Jain et al concluded that erosive potential of the soft drinks tested was not related to their pH value (25).

Fruit juices and fruit-based carbonated beverages have been described as having increased buffering capacities which may induce a prolonged drop in oral pH (26). Lussi and Jaeggi (27) opined that the greater the buffering capacity of a drink or food, the longer it will take for saliva to neutralize the acid. A higher buffer capacity of a drink or foodstuff will enhance the processes of dissolution because more ions from the tooth mineral are needed to render the acid inactive for further demineralization. In addition, when contain polybasic acids, these food or drinks exhibit buffering capacity that can maintain the pH below the threshold value (that is, at low or acidic pH values), even with marked dilution (28).

Jensdóttir et al. (29) from their study concluded that carbonated drinks, sport drinks and energy drinks were relatively easy to neutralize despite having a lower pH than fruit drinks. 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 (30, 31). An in vitro study by Grenby et al suggested titratable acid was a better guide than pH to determine erosive properties of beverages (32). However, total acidity or pH values of beverages could not be used with reliability to predict their potential to cause molar erosion (33).

Decreased erosion has been observed with increasing calcium content of a beverage at any given level of pH (23). Also, the addition of calcium and phosphate to some experimental drinks considerably decreased their erosive potential (34). Barbour et al. (35) therefore suggested product modification to reduce the erosive potential of drinks which may require additional methods such as the addition of calcium salts.

Modification of test soft drinks with low concentrations of calcium or a combination of calcium, phosphate and fluoride has been found to exert a significant protective potential with respect to dental erosion (36). However, a number of sodium phosphate supplements in low-pH beverages were not as effective as monocalcium phosphate in preventing molar erosion (33). Furthermore, the addition of polyphosphate alone or combined with calcium or xanthan gum were all said to reduce erosion of enamel compared with the unmodified soft acidic drink (37).

An animal study showed that acidic sport drink caused severe erosion with total loss of supragingival enamel and exposure to dentin. The erosive lesions were less severe and exposed dentinal tubules were partly occluded, when fluoride was added to the sport drink (38). Stannous fluoride has been suggested to be an interesting agent for use in the treatment and prevention of dental erosions even in patients with frequent vomiting episodes (39). Also, in an in vitro experiment, saturation with CaF2 reduced the development of erosions (40). A serious concern is the fact that acidic soft drinks were capable of dissolving considerable amounts of calcium fluoride and the erosion-preventive effect of even high fluoride concentrations is limited (12).

## Drinking habits

The individual manner of drinking acidic soft drinks has been said to affect how long the teeth are in contact with the erosive challenge (22) and therefore influence the pattern of destruction caused by them. The drinking method strongly affects tooth-surface pH and thereby the risk for dental erosion. Six different methods of drinking were tested in a randomized order by Johansson et al. (41): 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. Rapid erosion is seen when erosive drinks are consumed from a straw placed labial to the anterior teeth, or are “swished” between the teeth (42).

Edwards and coworkers recommended that drinking through a straw positioned toward the back of the mouth may reduce the erosive potential of soft drinks (43).

## Frequency of consumption

Statistically significant differences in susceptibility of deciduous and permanent enamel to erosion appear to emerge over time and with increasing frequency of consumption of acidic beverages (44). von Fraunhofer and Rogers (45), in their study of the effects of soft drinks and other beverages on dental enamel, concluded that reduced residence times of beverages in the mouth by salivary clearance or rinsing appear to be beneficial while Johansson et al. (46) from their study expressed that high erosion was associated with a method of drinking whereby the drink was kept in the mouth for a longer period.

## Adhesion of soft drinks to enamel

Significant differences in the ability of various drinks to adhere to enamel in vivo has been observed, therefore consumption of soft drinks with a lower ability to stick to the enamel surface than saliva was suggested to be preferable, as these drinks were presumably more easily displaced by saliva (47).

## Chelating properties

Most soft drinks contain phosphoric and citric acids but malic, tartaric, and other organic acids may also be present (48). The presence of these polybasic acids in beverages is important because of their ability to chelate calcium even at higher pHs (49).

## Dilution of juices

In a study to examine the effect dilution has on the potential erosive properties of the drinks. While dilution had very little effect on the measured pH values, the titratable acidity reduced as the drink became more dilute. Since there appears to be a direct relationship between dilution and titratable acidity, the erosive potential of diluting juices may be reduced substantially by the addition of water. It remains unlikely, however, that the drinks would ever be consumed at a ‘safe’ level of dilution due to diminished taste and colour (49).

## Temperature

Anecdotal reports show that erosion of teeth by soft drinks is likely to be influenced by the temperature of the beverages. One study by Eisenburger and Addy (50) concluded that erosion depth increased significantly with acid temperature.

It has therefore been suggested that acid beverages should be cooled before consumption and hence reduce the erosive effect (51).

## Liquid flow

A strong dependence of erosion on liquid flow has been suggested by Eisenburger and Addy (50). The association of severe erosion with certain habits of consuming soft drinks prompted a study of erosion in relation to fluid flow. In the experiment, citric acid solution (pH 3.2) was directed at polished enamel surfaces at different flow rates through outlets of varying diameters for up to 20 min. Erosion depth increased with time of exposure and total volume of solution, with increasing flow rate and with decreasing outlet diameter (42).

## Type of acid

Most soft drinks contain one or two common food acidulants - phosphoric acid and citric acid. Occasionally, other acidulants such as malic acid or tartaric acid are also used. Animal studies have shown that phosphoric acid is very erosive at pH 2.5 but much less so at pH 3.3. Citric, malic and tartaric acids are considered to be especially erosive because of their acidic nature and the ability to chelate calcium at higher Ph (48).

Citric acid was more erosive than malic acid when formulated to experimental drinks at high pH (23, 52). In an in vitro experiment West et al. (53) concluded that citric acid caused far more erosion over the pH range employed than phosphoric acid for enamel and dentine. Citric acid was found to compare with hydrochloric acid highlighted dissolution and chelation effects. Phosphoric acid caused minimal erosion over pH 3 for enamel and pH 4 for dentine.

## Anatomy of the soft tissues and physiological soft tissue movement

The anatomy of oral soft tissues in relation to the teeth and physiological soft tissue movements have been suggested to influence the tooth sites that acidic substances will contact and also the clearance pattern of acidic substances from the mouth (54).

## Socioeconomic factors

Behaviour can be strongly influenced by socioeconomic status. One study that looked at the relationship between dental erosion and socioeconomic status found that 4-year-old children from a low socioeconomic group had significantly less erosion than children from higher socioeconomic groups. The authors surmised that the observed differences may have been due to differences in dietary patterns and oral hygiene practices (55). A similar study by Milosevic et al (56) reported that the prevalence of tooth mineral loss in 14-year-old children was slightly positively associated with the level of social deprivation in the area where the children lived. Moss (54) argued that the direct comparison of both studies is difficult, since they involved different age groups and populations. However, they do suggest that behaviour which can influence dental erosion risk can stem from socioeconomic status.

## Healthier lifestyles

Many people today are in constant pursuit of ‘healthier’ lifestyles that involve regular exercise and healthy diets that include more fruits and vegetables. Exercise increases the loss of body fluids and may lead to dehydration and reduction in salivary flow. Satisfying an increased energy requirement and need for fluid intake with low-pH beverages during a time of decreased salivary flow could, theoretically, be doubly dangerous to the dentition. Competitive swimmers and cyclists have been reported as having higher levels of dental erosion (57).

## Unhealthy lifestyles

There were unhealthy lifestyles that have been be implicated in dental erosion. The use of the drug 'ecstasy' (3,4 methylenedioxy-methamphetamine) reduces salivary flow. The dry mouth combined with dehydration from vigorous exercise and excessive consumption of low pH drinks has also been linked to dental erosion (58). Dieting has also been considered a potentially important contributor to the aetiology of dental erosion. It is known that high consumption of fruits and fruit juices may be part of many individuals' weight reduction plans. A Swedish study noted that individuals undergoing fasting for health reasons frequently consumed herbal teas, some brands of which were found to be very acidic with a relatively high buffering capacity and low fluoride concentration. The investigators suggested that the combination of acidic drink consumption and reduced salivary flow associated with fasting may increase the risk of dental erosion (59).

## Dental erosion and dental plaque

By definition, dental erosion is a condition that occurs in the absence of plaque. Therefore, tooth surfaces that are constantly kept clean and lose the protection of the naturally acquired protein pellicle are more prone to erosion, while the opposite is true for the aetiology of dental caries. Dental plaque is known to have a much higher buffering capacity than saliva and may actually protect the tooth surface from acids of non-bacterial origin (60-62). Plaque accumulation on the palatal surfaces of maxillary anterior teeth were found to be lower in high-erosion subjects (46, 63). The presence of calculus or eating fruit other than apples or citrus fruit reduced the chances of erosion (64).

## Dental erosion and oral hygiene practices

Oral hygiene practices alone have long been implicated in tooth wear. Many studies have shown that the loss of tooth substance after exposure to citrus fruit juice is accelerated by toothbrushing. Levitch et al. (65) further suggested that a combination of erosion and abrasion may work synergistically to promote development of non-carious cervical lesions. The clinical implication of this is that toothbrushing immediately after ingestion of acidic foods or beverages may do more harm than good by accelerating tooth structure loss. Demineralisation of a tooth surface can be considered reversible in its early stages because it can be repaired by saliva. However, toothbrushing immediately after an acid challenge removes this partially demineralised tooth surface before saliva can repair it, thus resulting in an irreversible loss of tooth structure.

## Biological factors

Saliva is known to have many properties that can serve a protective function against dental erosion:

- dilution and clearance of a potentially erosive agent from the mouth;
- neutralisation and buffering of dietary acids;
- maintenance of a supersaturated state next to the tooth surface due to the presence of calcium and phosphate in saliva;
- formation of the acquired pellicle by the adsorption of salivary proteins and glycoproteins, which have the ability to protect the enamel surface from demineralization by dietary acids;
- presence of calcium, phosphate and fluoride are necessary for remineralisation (66).

In a study by Jensdottir et al. (67), salivary proteins were found to reduce the erosive potential of cola drinks by up to 50% while in another study urea concentration in unstimulated saliva were lower in high-erosion subjects when compared with low-erosion groups (46).

Several studies have revealed reduced salivary buffer capacity in patients with erosion when compared with controls (68, 69) while others confirm low salivary flow rates as the major determinants in some patients with erosion (70-72).

## Carbonation of beverages

In one study that compared acid clearance of noncarbonated and carbonated soft drinks in the mouth, there was no statistical difference in the clearance between the drinks. It was concluded that carbonation may not directly responsible for the erosive potential of different beverages (73).

## *Cola* and non-*cola* beverages

Some in vitro studies have shown that *cola* drinks, despite having the lowest pH on opening, were easier to neutralize than the fruit juices and non-*cola* drinks (34, 74, 75), while Jain et al. (76) concluded from their study that non-*cola* drinks were more erosive than *cola* drinks. The type of acid has been used to explain the ability of the non-*cola* drinks and fruit juices to resist pH change; phosphoric acid is normally used in the *cola* drinks while citric acid predominated in the fruit juices and the non-*cola* drinks (77). Surprisingly, an in vitro study has shown that citric acid caused far more erosion than phosphoric acid (53).

## Contribution of abrasive impact

In a study to investigate how enamel loss due to erosion and due to cycling of erosion and abrasion depends on compositional parameters of soft drinks. Enamel loss by erosion was exacerbated by subsequent abrasion. The amount of softened enamel removed by toothbrushing was said to be a function of the chemical composition of the erosive medium (78).

In a review by Magalhães et al. (79) abrasion of eroded enamel and dentin is dependent on the movement of toothbrushing, type of toothbrush, the applied brushing force and several toothpaste factors. Therefore, patients with erosive lesions should apply their toothbrushes with slight pressure to minimize loss of dental hard tissues, also use fluoridated toothpastes with low abrasivity for their oral hygiene measures.

## Factors related to the teeth

The composition of human teeth is known to be highly variable with respect to trace element concentrations and clinical studies have also shown marked differences in the response of various human teeth to acidic beverages. Also, the shape and contour of teeth in relation to drinking and swallowing patterns have been identified as factors that may modify the erosion process (54). First molar cuppings and buccal cervical defects were found more common in the high- than in the low-erosion group (46).

## Control of soft-drink incited dental erosion

If signs of erosion are detected at an early stage and appropriate steps taken, it may be possible to halt the progression to pain and destruction. Restorative treatment of extensive tooth wear is very expensive and time-consuming. It is essential to record accurately the severity and extent of the lesion. This will establish the clinical baseline so that any progression can be observed and the effects of preventive measures assured.

## Evaluation of the extent of tooth damage

In children, study casts and photographs aid the monitoring of dental erosion. In adults, these methods are also satisfactory although safe storage of study casts can be problematic. A silicone putty impression of the worst affected area is more readily stored with the patient notes and may be a helpful tool to assess progression. At a subsequent recall appointment, the putty index is sectioned labio-palataly and placed over the teeth. Any gap between the putty index and the tooth surface indicates progress of the erosion / wear and possible poor compliance with lifestyle changes. In children, growth and dento-alveolar development will preclude accurate seating of a putty index at review. A recall interval of one year is reasonable.

Epidemiological indices such as the Tooth Wear Index are tools for population based surveys and are not really applicable to monitoring at the individual patient level (80). Dentists who use epidemiological indices to monitor wear should be aware of the diagnostic criteria and the need to maintain good intra-examiner reproducibility.

## Evaluation of the aetiological factors

This is reliant on taking an in-depth history to include a detailed dietary history, medical history, dental hygiene habits and sensitive investigation about lifestyle factors.

Record a minimum three-day diet history to include a weekend and times of acidic food/drink consumption at bed time. The periodicity of eating and toothbrushing is also important. Such habits as continuous sipping or 'frothing' of drinks should be noted.

### Dietary counseling

This can only be given after a thorough analysis of the diet and influencing factors. It must be tailored to the individual bearing in mind the constraints that are operating on them. It needs to be given in a positive, individualised way to maximize compliance.

It will include:

- Limit acid foods and drinks to mealtimes. This is the time of maximum salivary flow and increased buffering capacity;
- Reduce frequency;
- The habit of frothing or swishing drinks around the mouth is likely to increase the risk of dental erosion and it is advisable that drinks are consumed quickly or if consumed slowly a wide bore straw placed toward the back of the mouth is advisable in order to reduce contact of acidic fluid with the teeth (81, 82);
- Avoid acidic food/beverges last thing at night;
- Finish meals with something alkaline such as a small piece of cheese or milk will neutralise intra-oral acid (83);
- Avoid toothbrushing after acidic beverages;
- Chewing gum has been shown to stimulate salivary flow (84) and increase buffering capacity, but may also cause increased gastric secretion. It should not be recommended for children, probably below the age of seven years and is not suggested for those with a history of gastric reflux.

### Prevention and treatment of sensitivity

The followings actions will not only to keep the patient comfortable but also will aid remineralisation:

- fluoride mouth rinses, varnishes and desensitising agents, to aid remineralisation and decrease sensitivity (85, 86);
- high fluoride concentration toothpaste (caution in children under six years) (87);
- low abrasive toothpaste (88);
- use of dentine bonding agents (89);
- Sugar free chewing gum (84).

### Monitor

When the patient returns for review, their compliance with all the advice given should be checked. Perhaps more importantly, the clinical situation must be examined very carefully. A localised silicone index should be taken of the original study casts in the area of most concern. This can be cut through with a sharp scalpel over the area (often the palatal aspect of the upper incisors). It is then transferred to be fit on to the patient. If there is any gap between the silicone index and the surface of the tooth then there has been further tooth surface loss. However, this would indicate fairly extensive surface loss. General comparison with the study casts and the clinical photographs is also necessary. These records have a number of errors inherent in their methods but can be useful in showing and educating patients about their erosion problems. There are more accurate methods such as replica techniques examined under the scanning electron microscope (57).

## RESTORATIVE TREATMENT

### Primary dentition

In the primary dentition, if the child is not experiencing any symptoms restorative treatment is not indicated. If teeth are sensitive, small areas of erosion may be covered with composite resin. Larger areas may require placement of composite crowns on anterior teeth and stainless steel crowns on posterior teeth. For severe symptoms, extraction of the offending teeth may be necessary.

### Mixed dentition

In the mixed dentition stage, the permanent dentition should be treated conservatively by either long term monitoring or the addition of dental composite resin to eroded surfaces.

Minimal space is required to bond composite resin without increasing the occlusal vertical dimension (OVD). Cupped and grooved surfaces can be restored to the enamel rim, which does not usually involve an increase in OVD. Dentine surfaces should be cleaned with pumice / water or slow speed rosehead burs prior to etching in order to remove the salivary pellicle and enhance bonding resin infiltration / penetration of sclerotic dentine. The poly-alkenoates or glass ionomers are themselves susceptible to acid erosion / dissolution and have no application in the eroding dentition (90).

### Permanent dentition

Assessment of the space in intercuspal position (ICP) is essential. The bonding of composite resin is reversible, reduces any sensitivity and improves appearance. Eroded labial, buccal and palatal surfaces can be restored with composite, veneers or dentine bonded crowns. Cupped occlusal sites are very amenable to composite in-fill.

### Palatal erosion of upper anterior teeth with no inter-occlusal space

The well-established management of this difficult restorative problem has been to provide a removable Dahl appliance (91). This is in effect an anterior bite platform which provides a posterior open bite. It allows relative extrusion of posterior teeth and intrusion of anterior teeth in order to gain space for the restoration of shortened, eroded upper anterior teeth. Once space has been gained then restoration of the anterior teeth may be carried out by a variety of means.

Clinical studies have supported the concept of restoring the worn upper anterior teeth at an increased OVD without the interim stage of a removable Dahl appliance as the restorations themselves have a Dahl effect (92). Localised temporary increases in the occlusal vertical dimension are extremely well tolerated and have become entirely predictable as a treatment modality.

### Generalised erosion

Generalised erosion of many surfaces may also result in mandibular overclosure, but in many cases compensatory over-eruption is likely to maintain the existing OVD. Evaluation of the FWS (Free Way Space) has also been recommended in order to determine the need or otherwise of encroaching upon it in order to restore the teeth.

It is considered that in situations where the FWS is normal, management is more difficult. Restoration of worn teeth results in an increased OVD and the interim use of an acrylic appliance at the desired new OVD has been recommended. Clinical studies in adults have not reported any long term increase in temporomandibular dysfunction (TMD) or dental problems (93-96). Restoration may be by way of conventional crown work or the application of adhesive technology such as composites or resin / dentine bonded crowns. Preventive programmes must remain the cornerstone in the management of dental erosion.

## CONCLUSION

There is some evidence that dental erosion is growing steadily. A number of literature reports conclude that excessive exposure to various acid sources can contribute to the chemical erosion of tooth surfaces. Paying closer attention to determinants of erosive attack is expected to minimize the harmful effects of drinks through proper patient education and interceptive procedures.

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