Dental Erosion: Part 2. The management of dental erosion

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SUMMARY

Dental erosion is an important cause of tooth tissue loss in both children and adults. An earlier article (Mahoney and Kilpatrick, 2003) discussed the prevalence and causes of dental erosion. This second article will discuss the management of this condition which is often complicated by the multifactorial nature of tooth wear. Management of dental erosion can be considered in three phases: immediate, interim and long-term. Immediate management includes the early diagnosis of dental erosion, recording the status of the disorder at baseline and implementing appropriate preventive strategies including those aimed at reducing the acidic exposure as well as those that attempt to increase an individual's resistance to erosive tooth tissue loss. Interim and long-term treatment includes the provision of temporary diagnostic restorations, ongoing monitoring of disease progression, definitive restorative work where appropriate, and modification and reinforcement of preventive advice. Each phase will be discussed in light of current evidence.

INTRODUCTION

This paper on dental erosion will review the management of dental erosion with the emphasis being on its prevention and treatment in children and young patients in which age group erosion is the primary cause of tooth tissue loss. The management of erosion can be considered in three phases: immediate, interim and long-term.

Immediate management

The most important aspect of the management of erosion is early diagnosis. While it is important to treat any acute dental sensitivity or pain resulting from the tooth surface loss, it is also essential to establish the aetiology, to eliminate the cause where possible, and to instigate proactive preventive strategies. As in the management of dental caries, the restorative approach is likely to be relatively ineffective if the aetiological factors persist.

A full history and examination are essential to identify the underlying cause (Watson and Tulloch, 1985). Determining the cause of the erosion can be complicated by the multi-factorial nature of tooth wear. The management of tooth wear relies on the patient's understanding the condition enough to be able to provide sufficient information for the clinician to arrive at a differential diagnosis (Smith et al, 1997). In some instances patients may not volunteer sensitive information (such as the existence of an eating disorder) when initially questioned (Chu et al, 2002a). It may take several visits before the underlying cause becomes evident. This provides the opportunity to build a relationship with the patient and to simultaneously develop some general preventive strategies to minimise the effect of the erosive process (Table I). Prevention of ongoing erosion can take two forms: reducing exposure to acid and enhancing the ability of the oral cavity to resist the effects of the acidic environment.

Reducing the acid exposure

Dietary counseling should be provided to everyone with evidence of dental erosion, irrespective of the aetiology. Due to the relative lack of clinical studies in the area, preventive dietary advice is essentially based upon common sense but should be in line with the dietary requirements for good general health (Moynihan, 2002). Dietary counseling does, however, need to take account of the exact aetiology and be personal, practical and positive. To simply advise against "all carbonated drinks" is unlikely to be effective. To reduce overall exposure it is suggested that such drinks may be taken as a treat occasionally and that intake should be limited to meal times at which time salivary flow is greater and the acids may be buffered more effectively. Where the cause is frequent vomiting, advice to rinse the mouth out with water or to avoid brushing the teeth for at least an hour after the event can also help (Attin et al, 2001).

It has been suggested that people who have swishing or sucking habits while drinking are at significant risk of erosion (O'Sullivan and Curzon, 2000a). It is therefore important to advise patients with erosion to swallow any potentially-erosive beverages immediately. The use of straws should also be encouraged for acidic beverages, as this will force the fluid to the back of the mouth, bypassing the anterior dentition (Edwards et al, 1998).

Another preventive strategy is to suggest positive alternatives. Traditionally, such advice has been limited to recommending water, milk or "sugar-free" diluted cordials. However, the reality is that the daily intake of soft drinks is likely to remain high. The United Kingdom National Diet and Nutrition Survey (Gregory et al, 2000) reported a mean daily intake of 152ml of carbonated soft drinks, compared to only 60ml of water. In response to increasing concern about dental erosion there has been some interest in the modification of potentially erosive beverages to minimize the effects of erosion. Three approaches have been reported to date. The first has involved raising the pH, reducing the titratable acidity and adding calcium to soft drinks (Hughes et al, 1999; West et al, 2003). More recently, researchers have reported further preventive benefits from the addition of a hydrocolloid food gum to the original modified product (Hughes et al, 2002). An example of such a product (which has been shown to cause less erosion than unmodified control drinks) is marketed in the United Kingdom as Ribena ToothKind ((Ribena^{RTM}, Glaxo SmithKline, Brentford, Middlesex, UK). A second but less effective approach has been to add large amounts of calcium fluoride to soft drinks, to supersaturate the environment around the tooth (Larsen, 2001) Finally, minimal concentrations of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) added to sports drinks (namely Powerade^{RTM}) have been shown *in vitro* to reduce their erosive effect, without detracting from the taste of the drink (Ramalingam et al, 2004). While they show promise, these products have yet to be available commercially and therefore the mainstay of dietary advice remains encouraging the consumption of water whenever possible.

Enhancing resistance to the acidic environment

A second preventive approach involves improving the resistance of the oral tissues to the effects of erosion. This can be achieved by increasing the resistance of tooth tissue to dissolution, or by improving salivary function. Saliva has been shown to be capable of promoting remineralisation of early erosive lesions (Hall et al, 1999; Amaechi and Higham, 2001).

TABLE I – Practical prevention of erosion.

Reducing acid exposure	Inform patients of types of foods and drinks that have greatest erosive potential
	Consumption of still/non-carbonated drinks as an alternative
	Limiting the intake of acidic foods/drinks to meal times
	Decrease time taken to consume acidic drinks, ie, not holding carbonated drinks in mouth, reducing sipping habits
	Advocate consumption of a neutral food immediately after a meal, eg cheese
	Rinsing mouth out after acid exposure, eg after episode of vomiting
	Avoid brushing teeth for at least 60 minutes after acid exposure (extrinsic or intrinsic causes)
Optimising salivary function	Increased water intake
	Use of water bottles in school bags
	Use of water dispensers or water jugs in work environment
	Avoiding caffeine and alcohol containing products
	Advise use of sugar free chewing gum to enhance salivary flow
Enhancing resistance to erosion	Advise the use of a neutral fluoride mouthwash or gel
	Advise use of Recaldent™ Chewing Gum to optimise salivary flow and enhance remineralisation
	Apply Tooth Mousse™ to enhance remineralisation and reduce sensitivity

Sub-optimal salivary function can enhance the detrimental effect of both bacterial acids (as seen in dental caries) and non-bacterial acids (as in erosion), with the buffering capacity of saliva being shown to be the most significant risk factor in the development of erosion (Gudmundsson et al, 1995; O'Sullivan and Curzon, 2000b). A simple saliva test for use in the dental surgery has recently been developed whereby both the amount and the buffering capacity of saliva can be crudely assessed ("Saliva-check Buffer", GC Corporation, Itabashi-ku, Tokyo, Japan). Where a deficiency in the quantity or quality of saliva can be established, the individual needs to increase their water consumption, to improve their hydration. However, there are a number of other strategies for optimizing salivary function (Atkinson and Baum, 2001) which are outlined in Table I.

The traditional approach to enhancing the resistance of enamel to cariogenic demineralization is through the use of topical fluoride. The application of a topical fluoride creates a layer of calcium fluoride on the tooth surface which serves as a fluoride reservoir promoting the formation of fluorhydroxyapatite which is less soluble than hydroxyapatite. The role of fluoride in the prevention of erosion remains unclear (Larsen, 2001; Ganss et al, 2001; Larsen and Richards, 2002). It is possible that the very high concentrations of acid seen in erosion actually dissolve the residual layer of calcium fluoride, thereby minimizing its effect (Larsen and Richards, 2002). However, there is evidence to suggest that high concentrations of topical fluoride can retard the progression of erosion in dentine, possibly because larger amounts of fluoride become deposited in the porous structure of dentine and act as a diffusion barrier (Ganss et al, 2001). In short, the use of neutral topical fluoride is still considered a useful strategy in the prevention of dental erosion, despite mixed evidence of its effectiveness.

To help neutralise an acidic attack following vomiting or reflux, sucking sugar-free antacid tablets has been recommended. Rinsing with a small amount of sodium carbonate or baking powder dissolved in a small glass of water has been suggested (without an evidence base of effectiveness) for patients suffering from erosion (Imfeld, 1996). Placing a small amount of these materials or neutral fluoride in custom-made, tightly-fitting trays either in the dental office or overnight at home may be useful in increasing the time the active agent remains in the mouth (Chu et al, 2002a). Using trays may also minimise the unpleasant taste experienced. Patients who suffer from reflux at night may, however, trap the intrinsic acid in the trays, worsening their erosion, although not all authors agree that this is a risk (Shaw and Smith, 1998).

An alternative approach to increasing the resistance of enamel to dissolution is the application of casein phosphopeptide-amorphous calcium phosphate (CCP-ACP). The casein phosphopeptides are produced from milk protein and have the ability to stabilize calcium phosphate in solution (Reynolds, 1998). CCP-ACP acts as a reservoir for calcium phosphate at the tooth surface, maintaining a state of supersaturation with respect to calcium and phosphate, thereby depressing enamel demineralization and increasing remineralisation. CCP-ACP is currently available in two forms, a sugar-free chewing gum (Recaldent™, a registered trade mark of Recaldent Pty Limited, Cadbury Japan Limited, Adams Division), and a topical application cream known as Tooth Mousse (GC Corporation, Itabashi-ku, Tokyo, Japan). The effectiveness of either of these products in preventing dental erosion has yet to be evaluated clinically, however the use of the chewing gum has been shown to result in significant enamel remineralisation in *in vitro* studies (Shen et al, 2001). These products may well offer significant advantages in the prevention and management of dental erosion, particularly when used with topical fluoride, as the effects of each are said to be synergistic, resulting in the enhanced localization of fluoride at the tooth surface (Reynolds, 1998).

Finally in the immediate phase of treatment of erosion, attention must be paid to any sensitivity or pain being

experienced by the patient. Particularly in young patients erosive tooth loss can be so rapid that secondary dentine does not have time to form, because of pulpal inflammation. The use of a glass ionomer cement as a sealant may resolve the sensitivity (Figure 1). This material can be applied with minimal discomfort, there being no need to either etch or strongly dry the affected tooth surface. The application of such a temporary material can also act as a diagnostic aid by immediately resolving the sensitivity.

FIG 1 – A glass ionomer "sealant" placed over the occlusal surface of a sensitive lower molar affected by erosive tooth loss.

Interim management

Early diagnosis followed by implementation of preventive strategies may, in many cases, be sufficient treatment. Ideally, interventive strategies should be delayed until the effect of the prevention on the rate of tooth wear can be assessed. However, apart from some complex research-based tools such as computerized systems to map tooth surface profiles (Mitchell et al, 2003), monitoring the progress of tooth wear clinically is somewhat subjective, relying on study casts and/or clinical photographs (Smith et al, 1997). Photographs should be in colour and of good quality and are useful not only to monitor disease progress but also as an educational tool for the patient. Alginate or rubber-based impressions should be taken at regular intervals through treatment, from which study casts can be poured (ideally with vacuum-mixed die stone) allowing detailed extra-oral evaluation of all wear features (Johansson and Omar, 1994). Neither method is very precise, but a combination of the two can provide a gross subjective estimate of the ongoing rate of loss of tooth tissue.

Clinical indices are another way to record the severity of erosion and allow the ongoing monitoring of its progression. All existing clinical indices assign a number or symbol to each tooth (or sets of teeth) in the mouth, depending upon the severity of erosion, and this can easily be updated at every subsequent appointment. There have been numerous clinical indices developed by various authors to record dental erosion. Many of these indices are time-consuming and complicated to use and do not differentiate between the different causes of tooth wear (Lussi, 1996). The use of very simple indices runs the risk of their not being sensitive enough to monitor subtle changes in the rate of disease over time. We have found the index developed by O'Sullivan (2002) specifically for recording erosion (as opposed to more general tooth wear) to be clinically useful. This index is shown in Figure 2. It has been suggested that the entire dentition should be assessed, rather than inspecting only a few selected seemingly representative teeth, because of the wide variation in the distribution patterns of erosion (Lussi, 1996).

In more severe cases, when persistent sensitivity, pulpal exposure, uncontrolled tooth tissue loss or cosmetic problems exist, active treatment will be required. Erosive tooth wear in young people is often localized to the palatal aspects of upper incisors and the occlusal aspects of first permanent molars. Treatment should be aimed at restoring the missing tooth structure, preventing further tooth tissue loss and maintaining an occlusion with balanced contacts.

Site of erosion
Code A: Lingual or buccal only
Code B: Labial or palatal only
Code C: Occlusal or incisal only
Code D: Labial and incisal/occlusal
Code E: Lingual or incisal occlusal
Code F: Multisurface

Grade of severity for each individual tooth
Code 0: Normal enamel
Code 1: Matt appearance of enamel- no loss of contour
Code 2: Loss of enamel only- loss of surface contour
Code 3: Loss of enamel with exposure of dentine
Code 4: Loss of enamel and dentine beyond ADJ
Code 5: Loss of enamel and dentine with exposure of pulp
Code 9: Unable to assess eg. SSC

Area of surface affected
Code – ve : Less than half of surface affected
Code + ve : More than half of surface affected

FIG 2 – The O'Sullivan Index for recording tooth tissue loss. Modified from O'Sullivan (2000).

Table II summarises the techniques currently available to restore teeth affected by dental erosion along with some of the evidence regarding their durability. Cast metal (most commonly nickel chromium cemented using a resin based cement such as Panavia X (Kuraray Medical Inc, Kurashiki, Okayama, Japan) can be used highly successfully both anteriorly as palatal veneers (Figure 3), and posteriorly as onlays (Figure 4) (Nohl et al, 1997; Chu et al, 2002a; Chu et al, 2002b). Although there are no studies reported on the durability of such restorations in erosion cases, there are reports of their use in the management of hypoplastic molars (Harley and Ibbetson, 1993; Zagdwon et al, 2003). Whilst failing to show any significant improvement in durability of cast onlays when compared with stainless steel crowns in the management of hypoplastic molars, Zagdwon and co-authors did acknowledge that these were completed with minimal additional tooth tissue removal, a factor of particular benefit when managing dental erosion. This is also a big advantage when restoring eroded teeth which have already undergone significant tooth tissue loss. In young patients a particular problem can arise anteriorly, where the dull grey colour of the sandblasted fitting surface of the cast veneer may "shine through" the thin translucent enamel of a young eroded incisor. Placement of direct composite after the cementation of the cast veneer may help to mask this (Figure 5 a-e).

Despite the clear advantages and proven durability of cast restorations, aesthetic considerations can make them unacceptable to some patients (and often, to their parents). Composite resin is obviously more aesthetically acceptable and can be placed directly (for instance, for anterior labial veneers), or indirectly. The latter can be particularly useful with posterior teeth, where controlling the occlusion when placing multiple direct onlay-type restorations can be difficult. Figures 6 a-e show an example of three posterior indirect composite onlays being placed under rubber dam using a resin-based adhesive.

Whilst the use of direct composite resin veneers is widely accepted for the management of all forms of tooth tissue loss in the anterior region, the durability of indirect composite veneers and/or onlays is less well reported (Hemmings et al, 2000; Gow

TABLE II – Summarises the treatment options for the management of dental erosion.

Material	Advantages	Disadvantages	Durability
Cast Metal (nickel/chrome or gold)	Fabricated in thin section - require only 0.5mm space Very accurate fit possible Does not abrade opposing dentition Protective of residual tooth structure	May be cosmetically unacceptable due to "shine through" of metallic grey Cannot be simply repaired or added to intra-orally Suitable for posterior restorations in parafunction Multiple appointments required	Success rate of 89 percent for palatal veneers over 4.5 years (n=210) (Nohl et al, 1997).
Composite – direct	Least expensive May be used as a diagnostic tool Can be added to and repaired relatively simply intra-orally Aesthetically superior to cast metal Single appointment	Technically difficult for palatal veneers Limited control over occlusal and interproximal contour Requires minimum of 1.0mm space Possible inadequate wear resistance for posterior use	Success rate of 86 percent for labial veneers over 3 years (n=289) (Welbury, 1991).
Composite – indirect	Can be added to and repaired relatively simply intra-orally Aesthetically superior to cast metal Control over occlusal contour and vertical dimension	Inferior marginal fit May be bulky Possible inadequate wear resistance for posterior use Requires at least two appointments Expensive	Success rate of 96 percent for palatal veneers over 2 years (n=75). (Gow and Hemmings, (2002)
Porcelain	Best aesthetics Good abrasion resistance Well tolerated by gingival tissues	Potentially abrasive to opposing dentition Brittle, should be used in bulk Hard to repair Expensive	Multiple studies suggest a success rate in excess of 90 percent over 5+ years (Aristidis and Dimitra, 2002; Dumfahrt and Schaffer, 2000).

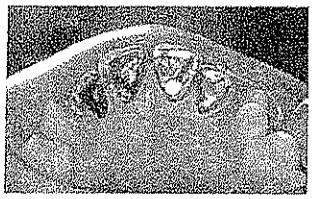

Figure 3. Cast nickel/chrome palatal veneers on upper permanent incisor teeth.

Figure 4. Cast nickel/ chrome onlays on lower permanent molars and premolars.

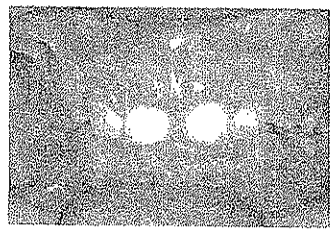

Figure 5a. Appearance of the upper permanent incisors of a 12-year-old boy with significant dental erosion.

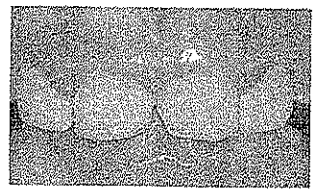

Figure 5b. The placement of cast palatal veneers has left a residual "shine through" of the grey sandblasted fitted surface.

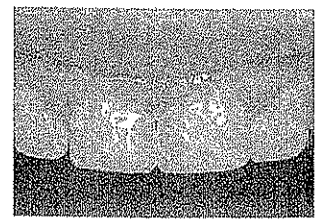

Figure 5c. Final appearance of the upper incisors following placement of direct composite veneers to mask the "shine through" of the cast palatal veneers.

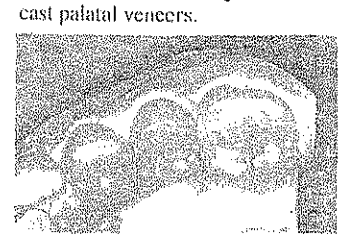

FIG 6a – The appearance of three direct composite onlays on the working model prior to placement.

FIG 6b – The placement of a posterior onlay under rubber dam.

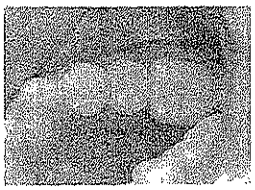

FIG 6c – Final appearance of posterior indirect composite onlays *in situ* on the lower permanent molar and premolars.

and Hemmings, 2002; Redman et al, 2003). After a preliminary period of only two years, 75 Artglass palatal veneers were evaluated as being satisfactory, with only 13 percent requiring minor repairs which were easily achieved using direct composite or polishing alone (Gow and Hemmings, 2002). Furthermore, the authors acknowledged that many restorations were placed in such a way as to increase the vertical face height, but that within nine months of placement the posterior occlusion was restored satisfactorily and without symptoms. Controversy exists over the risks associated with encroaching into the interocclusal space. However, there is evidence to suggest that if a balanced occlusion is maintained, increases in vertical dimension can be tolerated, particularly by young patients in whom marked changes occur naturally throughout adolescence and into early adulthood (Rivera-Morales et al, 1991; Hunter and Stone, 1997; Hemmings et al, 2000; Dyer et al, 2001; Redman et al, 2003).

Long-term management

All patients with tooth-surface loss should be reviewed regularly (depending upon the cause, severity and rate of progression of erosion) in order to monitor future tooth surface loss, maintain the existing restorations and provide support for the patient. Individuals with eating disorders in particular are prone to periods of relapse, and the dentist is in an ideal position to detect these periods. The dentist can develop a trusting relationship with the young patient over the longer term which is based on seeing the patient not just when they are "ill", and need to be counselled, but also when they are well, to provide support and encouragement. In the same way, patients with dietary erosion need constant reinforcement and support to maintain dietary change.

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