

Investigation and Treatment of Patients with Teeth Affected by Tooth Substance Loss: A Review

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Abstract: Tooth substance loss, an increasing problem, may result from erosion, abrasion and attrition, often with more than one of these acting together. Investigation requires a detailed history and examination. The aim of treatment may be prevention of further damage in less affected cases. The treatment of severe tooth substance loss may be complex, especially in view of the reduced amounts of tooth substance which may be available and the need to find space because of the compensatory over-eruption of worn teeth.

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Clinical Relevance: Management of tooth substance loss requires a detailed history to determine causative factors followed by measures to control further tooth substance loss and an organized approach if restorative intervention is indicated.

Tooth wear/tooth substance loss is becoming an increasingly common problem, especially in the younger population.¹⁻³ Management of the condition involves, in the first instance, addressing the cause of the problem^{4,5} and thorough investigation is required in order to identify the principal aetiological factors. Adequate investigation of the case may be one of the most important factors influencing the success of treatment.⁶ A detailed case history should therefore accompany the clinical examination to ensure that all possible aetiological factors are investigated, as a number of different aetiologies may work together.⁷

TAKING A CASE HISTORY

Establishing the Patient's Complaints

A full history is essential for the

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assessment of the nature and duration of the tooth wear problem,⁸ and identification of the underlying cause is vital for the long-term prognosis of the dentition and the restorative therapy prescribed.³ Initially it will be important to ask the patient about his/her symptoms, including the time for which he/she has been aware of the problem(s) and whether it is believed to be progressing.⁶ In addition to providing clues as to the nature and duration of the problem, this information will help to determine the form of treatment to be offered by giving an indication of what factors are of most concern to the patient.⁸

The most common presenting complaint is related to aesthetics,⁹ although levels of concern vary between patients.⁶ In other instances, patients may complain of irritation from worn or fractured teeth^{8,9} or functional problems such as difficulty in biting into food.¹⁰ Less commonly, patients complain of sensitivity,^{3,10-12} although this may be a sign that tooth substance is being lost more rapidly than secondary dentine can be deposited to protect the pulp^{3,13} and indicates that the problem needs to be

addressed before the pulp becomes irreversibly damaged.

The patient's reason for seeking treatment will suggest how keen he/she is to receive treatment and what particular factors should be addressed.⁶ Past dental history may also help provide information on his/her attitude to, and likely compliance with, dental treatment.⁶ If the patient's commitment is in any way suspect, the simplest treatment option should be followed, as more advanced treatment is likely to demand increased co-operation from the patient.⁶

Medical History

As with all clinical histories, the medical history must be established before commencing treatment, but in the case of tooth wear it is of particular relevance as a number of medical conditions are significantly associated with loss of tooth substance. Among these are gastric disorders such as gastro-oesophageal reflux, sphincter incompetence, hiatus hernia, oesophagitis and increased gastric pressure and volume.⁵ Patients suffering from gastric ulceration may also suffer from acid regurgitation. Questioning should therefore be directed towards any known gastric symptoms such as reflux or heartburn.^{8,11,14} It is, however, possible that subclinical reflux may involve entry of enough acid into the mouth to cause erosion without the patient being aware of the problem.¹³

Gastric acid also enters the mouth during vomiting and, if this occurs frequently over a prolonged period, erosive tooth surface loss may occur.² Vomiting can result from disorders of psychosomatic, gastrointestinal and metabolic processes or may be drug

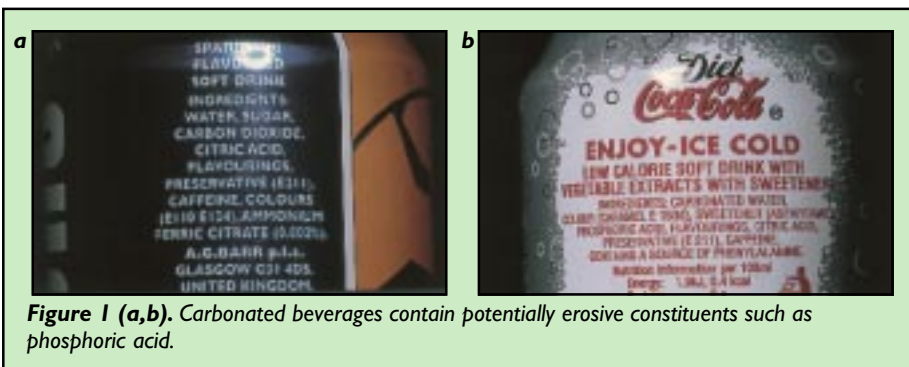


Figure 1 (a,b). Carbonated beverages contain potentially erosive constituents such as phosphoric acid.

induced.² The patient should be asked whether he/she has suffered any such incidents.⁹

Pregnancy may also be considered an aetiological factor in tooth wear¹⁰ as the increased pressure in the abdomen may predispose to regurgitation,³ and this can be compounded by the repeated vomiting of morning sickness.¹⁵ A female patient of child-bearing age presenting with tooth wear should be asked if she is pregnant¹⁶ or has suffered from reflux during previous pregnancies.¹³

The patient should be asked about eating disorders such as anorexia and bulimia, if these are suspected, as repeated self-induced vomiting⁴ or replacement of normal dietary components with large quantities of acidic foods and low calorie drinks^{5,17} may cause significant damage to teeth. It should be noted that more female patients are affected by these conditions than males (ratio of 10 to 1.5). The nature of eating disorders makes it unlikely that the patient will admit to such a problem on direct questioning⁵ but a suspicion may be raised with regard to the patient's general appearance and body shape.^{8,17} Indirect questioning relating to past and present slimming habits¹⁶ and self-image may provide useful clues as to the likelihood of the patient being anorexic or bulimic.¹⁸ Indeed, patients suffering from eating disorders are likely to be able to give their exact weight on questioning, which unaffected members of the public are usually unable to do. It may be that eating disorders account for a significant proportion of patients for whom no reason for tooth substance loss can be determined.

A complete medical history also includes any medications the patient is taking; this is of relevance as a number of drugs may predispose to tooth substance loss.¹² The most significant appear to be acidic compounds such as hydrochloric acid for achlorhydria,^{3,16} iron preparations² or chewable vitamin C.^{3,15,16} Other drugs may have a less direct role to play, for example, diuretics and antidepressants¹⁵ cause xerostomia,^{1,3} thereby reducing the amount of saliva present to lubricate tooth surfaces and buffer acids in the mouth.¹

The medical history is valuable for identification of intrinsic sources of acid causing dissolution of tooth substance. The drug history may identify extrinsic sources of acid, but the most common source of extrinsic acid is the patient's diet.² Where erosive tooth wear is suspected, an accurate diet history is therefore essential. Initially the patient should be asked if he/she follows any special diet¹⁴ or is aware of consuming above-average amounts of any particular foods or drinks.⁹ In particular, the patient should be asked about the volume and frequency of consumption of the common erosive foods (fruit juices, soft drinks, carbonated drinks, citrus fruits and pickles) over a typical day or week (Figure 1).¹¹ Probably the most appropriate dietary investigation is the three-day diet diary, in which the patient notes *everything* they consume over three consecutive days.^{2,17,19} When analysing the diet diary it should be borne in mind that, in addition to foods that are in themselves acidic, some dietary components—such as spicy foods and onions—can induce gastric reflux.³

Eating and Drinking Habits

In addition to the content of the patient's diet, his/her eating and drinking habits should also be considered. The frequency of eating should be ascertained,^{18,19} as a large number of repeated acid attacks pose a greater risk than one isolated incident.² Other habits that may place tooth substance at risk to dissolution include holding citrus fruits against the teeth⁹ or 'swishing' carbonated drinks in the mouth until the gas escapes.^{2,18} It is important to identify any such habits so that the patient can be advised of the damage they cause and encouraged to stop.

Other aspects of the patient's lifestyle may also be of relevance and should be investigated. Their past and previous employment should be noted as, in addition to providing information on socio-economic status, they may provide clues as to the nature of the tooth wear.^{6,8,19} In the past, 'industrial erosion' was frequently described in people exposed to acidic fumes^{3,4,15,16} but it is unlikely to be a factor today due to the more stringent industrial legislation.

Hobbies and sporting activities may also be of relevance. For example,

Erosion:

- Smooth, polished appearance^{1,3,21,12,25}
- Absence of developmental ridges⁴
- Rounded teeth^{1,3,12,19}
- Increased translucency due to thinning of enamel^{1,26}
- Cupping and/or grooves^{1,3,14,26}
- Amalgam and composite restorations stand proud^{3,12,14,26}
- Base of lesion not in contact with opposing tooth^{3,12}
- Absence of staining^{2,25}

Abrasion:

- Rounded or V-shaped groove¹⁴

Attrition:

- Flat cup tips or incisal edges (dentine and enamel wear at the same rate)³
- Localized facets on occlusal or palatal surfaces³
- Flat facets related to functional movements¹⁴
- Restorations show faceting as well as teeth³

Table 1. Features of erosion, abrasion and attrition.

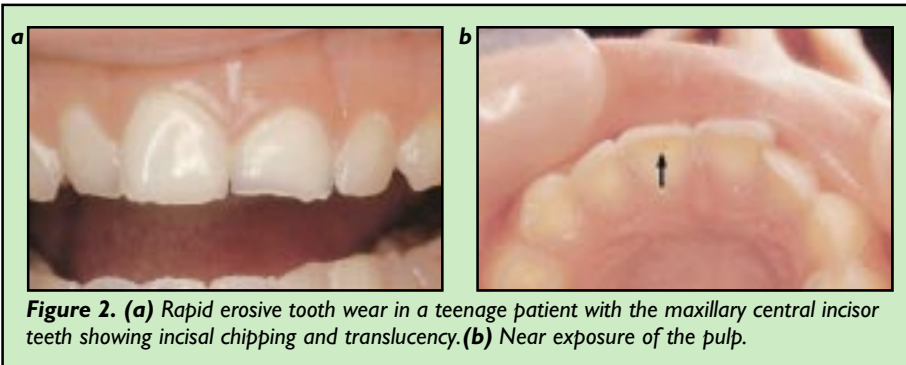


Figure 2. (a) Rapid erosive tooth wear in a teenage patient with the maxillary central incisor teeth showing incisal chipping and translucency. (b) Near exposure of the pulp.

erosion is more common in people who swim regularly in gas chlorinated pools where the water is acidic.¹⁹ Vigorous exercise will result in dehydration and damage will be compounded if acidic 'sports drinks' are consumed after exercise.^{1,2}

Alcohol intake is also a major factor in erosive tooth wear, given that binge drinking followed by vomiting^{1,3} may cause substantial damage. Patients should therefore be asked to give details of the frequency of alcohol consumption and the amount they tend to drink at one time.¹⁶ Recreational use of drugs such as LSD or ecstasy (MDMA) have also been implicated in erosion^{2,18} due to the low pH of the drug or dehydration it induces. While such topics should be addressed, dentists should be aware that the patient might not give an honest answer.

Abrasion and Attrition as Causes of Tooth Substance Loss

To this point, questioning has been directed towards possible erosive factors. This may be considered appropriate as it has been argued that identification of erosive factors is highly important in determining the approach to treatment and likely prognosis.¹² Erosion is believed to be the most common cause of tooth wear, as demonstrated by the study by Smith and Knight in 1984,¹⁶ in which only 11% of patients studied did not involve erosion.

Even when an erosive factor is established, it is necessary to continue to investigate other possible wear processes (attrition and abrasion) because several aetiologies often act together⁶ so that

erosive lesions may be more accurately described as erosion–abrasion or erosion–attrition.¹³

Abrasion is tooth wear caused by a foreign object and is most commonly attributed to overzealous oral hygiene techniques.¹⁸ Toothbrushing soon (within one hour) after the teeth have been 'softened' by acid insult, use of an abrasive toothpaste or forceful brushing, may result in generalized tooth wear that is not confined solely to the classical cervical abrasion cavities. The patient's toothbrushing technique should therefore be assessed,^{2,16,20} and questions asked about the oral hygiene products used,¹⁶ the frequency of toothbrushing^{8,21} and how the timing relates to eating, drinking or vomiting.^{1,2}

Abrasion, particularly of the incisal edges, may result from holding items between the teeth.⁴ For example, localized areas of tooth wear may be seen in hairdressers who hold clips between their teeth,¹ and in musicians who play instruments with mouth-pieces that contact the teeth.¹⁰ Other habits that may lead to tooth wear include pipe smoking, pen chewing and nail biting.²² Such habits should be identified during questioning on lifestyle and habits, although direct questions could be necessary as patients might not associate the lesions with objects they often place between their teeth.

Attrition is wear resulting from tooth-to-tooth contact and is often associated with parafunctional habits such as clenching and grinding.^{1,3,6,18,23} particularly if the wear occurs on anterior teeth. Patients are often unaware of clenching or grinding habits³ though they

may complain of symptoms associated with parafunction, such as temporomandibular joint problems.⁶

Many delicate issues, such as eating disorders and drug or alcohol abuse, may be discussed in history-taking and patients might not be forthcoming with their responses. Interviews must therefore be conducted in a sensitive, non-judgemental manner.¹⁶ Certain factors might not come to light at the initial visit, but may be disclosed later once the patient feels able to trust the dentist.²⁴

EXAMINATION

Following a thorough history, examination of the patient's dentition will provide more information as to the aetiology of the condition. An extra-oral examination may identify a clicking TMJ or masseteric hypertrophy (associated with attrition⁶) or parotid enlargement (associated with bulimia¹⁰).

Intra-oral examination should begin by taking into account the general dental state, oral hygiene, gingival condition and restorations present.⁷ Attention can then be turned to the lesions of tooth wear, noting their location, extent and severity.^{6,17} The lesions should be examined further for features characteristic of the different wear processes shown in Table 1 (see also Figures 2, 3 and 4). While these factors may be useful in determining the pattern of tooth wear, the possibility of erosion should be considered even if the appearance suggests abrasion or attrition because the lesions may be of combined aetiology.



Figure 3. Cupped incisal edges. The initial tooth wear was due to a bruxist habit, but the cupping was caused by erosive dietary factors.

The distribution of tooth wear may provide additional clues to the underlying cause. For example, palatal erosion suggests an intrinsic aetiology,^{1,16,17,19,21} while labial erosion implicates extrinsic factors.^{1,14} Lesions involving incisal edges (Figure 3) and cusps are generally associated with attrition,^{16,19,26} although there may be some superimposed erosion in some cases. Asymmetric lesions may be due to abrasion.¹⁹

In addition to examining the teeth present, the absence of any teeth should be noted, given that lack of posterior support can predispose to anterior tooth wear.⁸ Interferences in lateral excursions should be identified²⁵ as they may encourage bruxism.⁸

Special investigations that may be undertaken include periapical radiographs, which provide an additional aid in determining proximity of lesions to the pulp⁶ and identification of any teeth where pulpal involvement has occurred, giving rise to a periapical area.^{7,26} In addition, it may be possible to measure salivary parameters,^{19,27} however, although this may provide additional information on the patient's susceptibility to tooth wear, it will have little influence on treatment prescribed—their importance in clinical examination is therefore likely to be minimal.

Tooth wear tends to be episodic in nature⁴ and it is possible that patients will present when chronically thinned tooth substance begins to fracture, although active destruction occurred at some point in the past and the causative factor is no longer operational.¹³ Where the history and examination do not identify causative factors, a period of monitoring may be required to determine whether active wear is still occurring.¹²

TREATMENT

Shaw and Smith (1999)³ stated that 'prevention must remain the corner stone in the management of dental erosion' and the first priority in treatment of all forms of tooth substance loss should be to control the aetiological factors and prevent further destruction of the already compromised tooth tissue.²⁴ Where the causative factors are endogenous, such as

medical disorders, cooperation with the patient's physician will be invaluable.^{1,2,15,24} The first line of treatment will involve counselling the patient in the avoidance of the agents implicated in causing the loss.⁴ Such preventive advice should be given in an individualized manner in order to maximize compliance² and will include:

- modifying the diet;^{2,5,19}
- changing eating habits and frequency of eating;^{2,19}
- instruction in non-abrasive oral hygiene habits;^{5,7,26}
- use of alkaline mouthrinses, such as bicarbonate of soda, following vomiting or reflux.^{2,5,24}

In addition to offering advice, measures to protect the teeth from further wear may be undertaken. Where a clenching or grinding habit has been implicated, a mouthguard or splint may be provided for night wear.^{1,8,15} The significance of the habit may be ascertained by examining the occlusal surface of the guard for signs of wear after use.^{6,13,16} A potential problem may arise, however, if a mouthguard is provided in the presence of a condition such as reflux because it would hold the acid against the teeth for prolonged periods and so increase the damage.¹³ This may be overcome by applying an alkali such as sodium bicarbonate, magnesium hydroxide or milk of magnesia to the fitting surface of the tray^{1,19} to neutralize any acids approaching the tooth surfaces. This principle may also be useful in cases where bruxism is not a major factor:⁶ for example, a splint containing a neutralizing solution worn overnight may protect the teeth in the presence of reflux during sleep.²

Neutral sodium fluoride mouthwashes are frequently prescribed in cases of tooth wear^{1,4,7,12,17,24,28,29} in an attempt to combat acid damage and control sensitivity.^{1,2,13,29} Although the benefits of fluoride are virtually indisputable in the management of caries, its value in cases of tooth wear is less clear.²⁶

The principles for treatment of caries have been established for over a century,



Figure 4. Amalgam restorations standing proud of remaining, eroded tooth substance. The patient was a bulimic who vomited over ten times per day for at least four years. The first molar had been restored several years previously with a crown because of tooth wear

but the principles for treating loss of tooth substance are less well developed.

Accordingly, much controversy surrounds the question of when interventional therapy should be undertaken, but it is generally agreed that a period of monitoring is required to assess the effectiveness of preventive therapy.^{13,15,28,29} Tooth substance loss generally proceeds slowly, so for most patients there is no pressure to commence active restorative therapy (the exception to this would be a young patient with rapid erosive tooth wear and sensitivity due to the loss of tooth substance encroaching on the pulp, or decreasing dental aesthetics due to chipping of incisal edges). Initial study casts and clinical photographs should therefore be taken on presentation to provide a baseline for comparison. Use of a silicone index to compare study models may aid reduction of subjectivity.² In some instances, stabilization of the situation by arresting the progress of the wear may meet the patient's requirements, and it might be sufficient simply to maintain the patient under regular review without undertaking any active restorative treatment.⁴

Where aesthetic problems are present from the start, it is almost inevitable that restorative treatment will be required—and requested by the patient (Figure 5), but a period of monitoring will still be useful to assess the rate of progress of wear, effectiveness of preventive measures and extent of treatment required.¹⁵ This period may also permit assessment of the patient's long-term

compliance with preventive advice before embarking on complex treatment.¹⁷

The point at which intervention should be undertaken is not always clear. It has been suggested that treatment should not commence until the tooth wear has stopped,^{1,19} but in cases where wear cannot be stopped or is progressing so rapidly that the pulp is at risk (Figure 5), steps must be taken to protect the teeth.^{1,29} The most logical approach would appear to be to institute prevention and monitoring, progressing to interventional measures only when they are indicated.^{15,19} Factors include tooth sensitivity or pain that cannot be controlled by conservative measures, or major aesthetic concerns.^{15,19} Therapy may also be indicated where stabilization fails to resolve dental problems^{1,13,29} and where progressive wear will result in problems with restoration at a later date.^{15,19}

In some cases, immediate therapy may be required using the minimum treatment necessary to address the problems⁵ before full restorative therapy at a later date. Where initial preventive therapy does not help, a dentine bonding agent may be applied to the tooth surface to seal exposed dentinal tubules,² or glass ionomer or composite may be placed over areas of severe wear.^{1,29} Persistent pain indicates pulpal inflammation in

response to acid attack²⁶ and in this situation endodontic treatment will provide a reliable, straightforward and permanent solution.¹³ This is, however, an extreme measure and should be undertaken only as a last resort when all other forms of treatment have failed to resolve the problem.^{29,30}

Bishop and co-workers in 1994 described the ideal material for treatment of tooth wear as being aesthetic, with proven durability, repairable in the mouth and requiring minimal tooth preparation.²⁹ Although advances in dental materials since that time have occurred, no one ideal restorative material or technique has been proposed.

Traditionally, treatment of tooth substance loss has been complicated by the unretentive shape of worn (short) teeth,^{4,13} requiring removal of large amounts of tooth tissue^{4,22} and even crown lengthening surgery^{4,10,22} or elective endodontic treatment followed by placement of a post and core^{22,24} to provide adequate retention for crowns. The advent of adhesive techniques has reduced the need for such extreme treatment^{5,25,29} and emphasis is now placed on minimally destructive techniques, especially in the younger patient where minimal secondary dentine is present.²⁹ However, for some patients, ultra-conservative measures will not be possible, and traditional techniques may

still be of value.³¹

The development of reliable bonding systems has had a major impact on treatment of tooth wear.¹⁰ Adhesive techniques allow early restorative intervention to be undertaken in order to provide protection to the remaining tooth structure.^{5,32} They allow for restoration with no (or minimal) tooth preparation^{10,25} such that procedures have been considered by Milosevic and Jones to be 'additive or constructive rather than subtractive or destructive'.¹⁰ In addition to avoiding the need for conventional crown preparations, adhesives may be used to retain partial coverage restorations,⁴ thereby avoiding the need to restore unaffected surfaces.

Though space requirements of bonded restorations are minimal,⁵ lack of interocclusal space remains a problem where compensatory over-eruption of worn teeth has occurred to maintain occlusal contact.³² Traditional measures for overcoming this problem may be destructive, involving either increased tooth preparation to provide space³² or crowning all posterior teeth in one or both arches to increase the occlusal vertical dimension.^{5,24}

Increasing the inter-occlusal space avoids the need to remove further tissue from damaged tooth surfaces and a number of techniques for this have been described. First, the occlusal vertical dimension may be increased, usually by crowning most of the teeth in one arch. This can result in much removal of sound tooth structure, but is of use in patients whose teeth are broken down or heavily filled and for whom extracoronary restorations are unlikely to cause much loss of sound tooth substance. Watson and Tulloch in 1985, following their treatment of a series of cases, proposed the following guidelines for treatment of patients affected by tooth substance loss which are now widely accepted.⁸ They classified their cases according to appearance, and the need to increase the occlusal face height, as follows:

1. Appearance satisfactory.
2. Appearance not satisfactory: no increase in occlusal face height required.

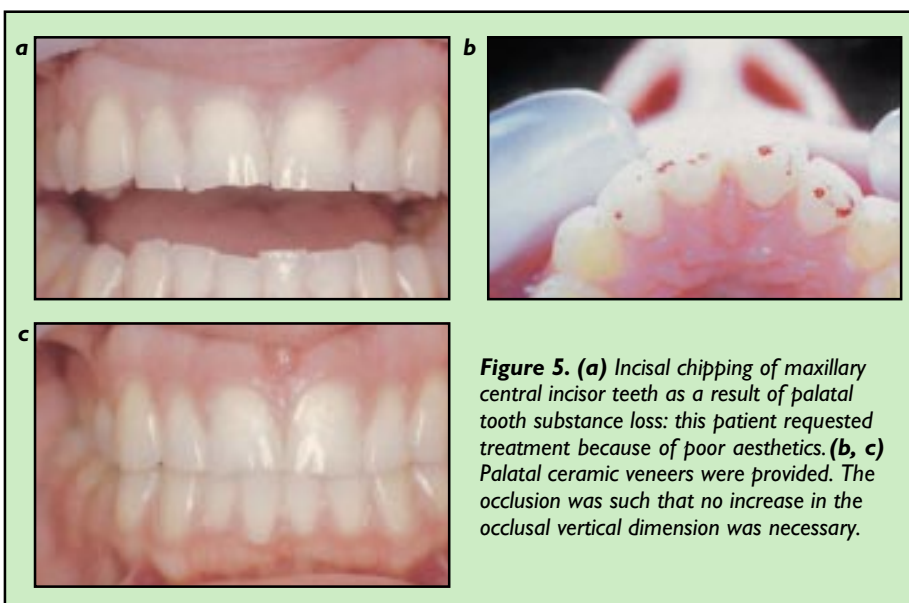


Figure 5. (a) Incisal chipping of maxillary central incisor teeth as a result of palatal tooth substance loss: this patient requested treatment because of poor aesthetics. **(b, c)** Palatal ceramic veneers were provided. The occlusion was such that no increase in the occlusal vertical dimension was necessary.

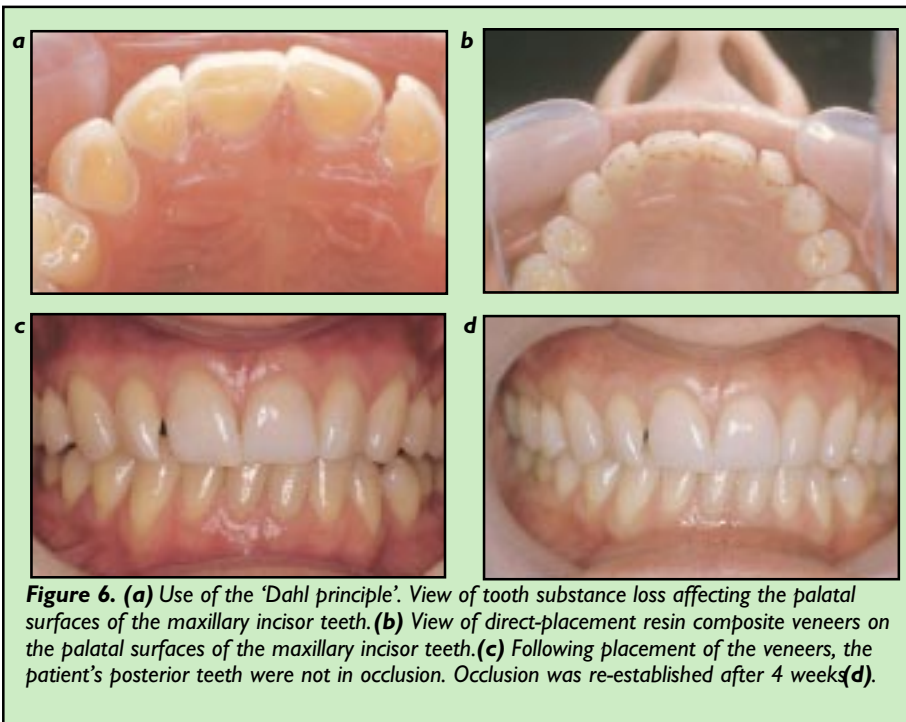


Figure 6. (a) Use of the 'Dahl principle'. View of tooth substance loss affecting the palatal surfaces of the maxillary incisor teeth. (b) View of direct-placement resin composite veneers on the palatal surfaces of the maxillary incisor teeth. (c) Following placement of the veneers, the patient's posterior teeth were not in occlusion. Occlusion was re-established after 4 weeks (d).

3. Appearance not satisfactory: increase in occlusal face height required:
- (i) sufficient space available;
 - (ii) insufficient space available.

For cases in category 1, treatment indicated is counselling, restoration of edentulous spaces where appropriate, treatment for controlling bruxist or clenching habits, adjustment and elimination of any occlusal interferences and routine dental treatment. Patients in category 2 are managed as for category 1 plus the treatment of the aesthetic problems by conventional restorative measures. Treatment of category 3 patients may be complex. At the outset, the clinician must decide whether the patient can tolerate the increase in occlusal vertical dimension.

Another, more simple classification is simply into:

- localized; and
- generalized.

It is rare for large numbers of teeth to be affected by tooth substance loss and it is more likely to be localized to a small number of teeth, usually in one arch. In

general, when a small number of teeth are affected, these teeth alone should be treated. However, treatment should also include the determination of the cause of the wear where possible so that the patient may be advised on prevention of future tooth wear (see below).

Generalized loss of tooth substance is usually a result of several contributory factors—for example, a bruxist who also consumes excessive quantities of carbonated beverages, especially at bedtime, or a bulimic who consumes excessive carbonated beverages and who brushes his or her teeth with an (abrasive) toothpaste shortly after vomiting. These patients will often require extensive restorative treatment, with the treatment dependent on the factors discussed below.

Orthodontic treatment may be used to create space.^{4,24,25} The Dahl appliance is a removable or cemented cobalt chrome appliance which covers the palatal surfaces of the maxillary anterior teeth. This allows contact of the mandibular anterior teeth with the appliance, holding the posteriors out of occlusion. This, in turn, promotes intrusion of the anterior teeth and eruption of the posteriors, thus providing space anteriorly for

restoration.^{4,21,24,29,32} A number of modifications on the Dahl appliance have been described, ranging from an acrylic removable appliance with a flat anterior bite plane²⁸ to direct placement of the restorations, leaving them intentionally high so that the restorations themselves act on the same principles as the Dahl appliance (Figure 6).^{24,25,31,32}

Restoration Materials

A wide range of treatment options exist using a variety of dental materials. Perhaps the simplest are composite and glass ionomer, which are particularly useful in the early stages as an interim measure.^{2,17,21} When required, these restorations can be repaired in the mouth^{26,30} and may be removed or adjusted easily.³² Composite appears to be more frequently indicated than glass ionomer due to its superior aesthetics,³² better wear resistance, and lack of solubility in acid: it is therefore preferred in cases where erosion is ongoing.⁵ Composite is, however, of limited value where extensive tooth wear has occurred due to its suboptimal resistance to contact wear.^{4,32} The lifespan of composite and glass ionomer is also shorter than materials such as gold or ceramic and such restorations will require repair or replacement relatively early.³¹ Nevertheless, despite their shortcomings, composite and glass ionomer materials may be combined with indirect techniques to protect tooth tissue and pulp by building out cupped areas to give a more favourable surface morphology.

In view of its strength and minimal space requirements, cast metal is an effective material. Appropriate metals include gold (which may be heat treated,^{25,31} oxidized²⁴ or tin plated⁷ to aid bonding) and non-precious alloys such as nickel chromium. The castings are commonly retained by a dual-affinity resin such as a 4-META adhesive.²⁵ They are generally used for partial coverage restorations on the palatal surfaces of anterior teeth^{7,25,32} where aesthetics are of minimal importance. Cast restorations provide a durable, non-abrasive occluding surface.^{7,29} The main problems are poor aesthetics, especially if they are

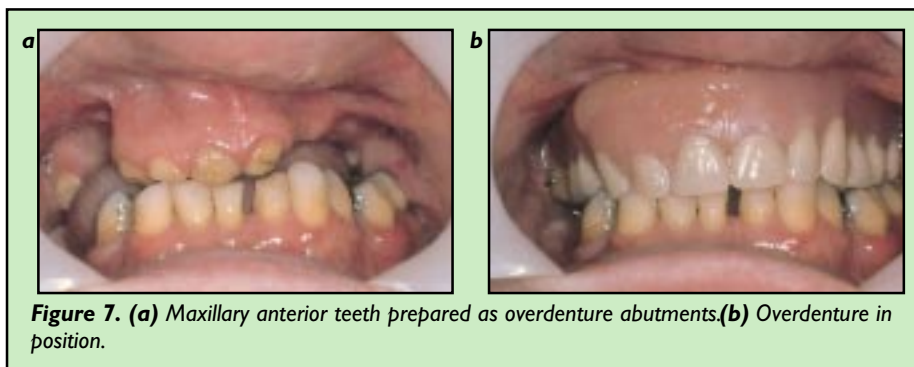


Figure 7. (a) Maxillary anterior teeth prepared as overdenture abutments. (b) Overdenture in position.

extended onto the incisal edges to ease location and increase the surface area available for bonding.³¹ If extension onto the incisal edge is deemed necessary, the metal can be made less conspicuous by dulling the polished metal with an intra-oral air abrasive.³¹ Aesthetics may even be a problem where metal is not extended over the incisal edge, due to 'grey out' of thinned enamel in the incisal third, particularly in young patients.^{7,25,32} This may be minimized by using an opaque luting cement³¹ or by undertaking an initial build up of the incisal edge with composite, followed by coverage of the tooth and composite with the metal veneer.³¹

Some clinicians have combined cast metal restorations with core porcelain where the metal will extend past the incisal edge.⁷ Where the labial surface is also significantly involved, a double veneer technique, as described by Bishop and co-workers in 1996⁷ and King in 1999,³¹ combines the advantages of palatal metal veneers with the aesthetics of porcelain on the labial surface.

A number of porcelain techniques have also been described. Porcelain laminate veneers on either the labial or palatal surfaces may provide highly successful restorations in light of their ability to bond to dentine and enamel, their strength, durability, wear resistance, biocompatibility and aesthetic properties.²¹ Adhesion is enhanced by etching the fit surface of the porcelain with hydrofluoric acid in the laboratory.^{7,29} The use of a dual-cure resin with a selective shade range will ensure optimal aesthetics.¹⁷ Problems may arise where palatal veneers are used because

they require greater inter-occlusal space; if porcelain extends beyond the incisal edge, difficulties may also be encountered in disguising the junction between porcelain and tooth.³¹

In cases where both labial and palatal surfaces are worn, full-coverage ceramic crowns are effective.^{10,24} It has been suggested that use of dentine bonding with all-ceramic crowns may provide the restoration with strength approaching that of natural tooth substance.^{10,24}

Problems with porcelain include its fragility, especially when unsupported as in build-up of worn incisal edges.^{7,10} In addition, its potential for abrading opposing tooth surfaces if not polished satisfactorily,^{7,32} and difficulty of repair,^{29,32} mean that the use of porcelain should be restricted in cases of attrition or where bruxism is a factor.^{7,22} Where parafunctional habits exist, metal or metal ceramic crowns may provide a more reliable result⁴ but it should be borne in mind that increased tooth preparation will be necessary.

Finally, tooth wear may be so severe that there is insufficient tooth substance remaining for crowns, even if crown-lengthening procedures are considered. In such cases, overdentures may be appropriate, especially if other teeth are missing (Figure 7).

CONCLUSION

Treatment of tooth wear may involve a variety of approaches. In all cases, emphasis should be on detailed history-taking to identify the main causative factors, followed by measures to control these factors before any form of

intervention. Where restorative management is indicated, the method chosen should be appropriate to the characteristics of the case and address the patient's concerns. The main objective in all cases should be to minimize the amount of tooth substance removed in treatment.

NOTE

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REFERENCES

1. Kelleher M, Bishop A. Tooth surface loss: an overview. *Br Dent J* 1999; **186**: 61–66.
2. Shaw L, Smith AJ. Dental erosion – the problem and some practical solutions. *Br Dent J* 1999; **186**: 115–118.
3. Dahl BL, Carlsson GE, Ekfeldt A. Occlusal wear of teeth and restorative materials. *Acta Odontol Scand* 1993; **51**: 299–311.
4. Milosevic A. Eating disorders and the dentist. *Br Dent J* 1999; **186**: 109–113.
5. Bishop K, Kelleher M, Briggs, Joshi R. Wear now? An update on the aetiology of tooth wear. *Quint Int* 1997; **28**: 305–313.
6. Williams DR. A rationale for the management of advanced tooth wear. *J Oral Rehabil* 1987; **14**: 77–89.
7. Bishop K, Bell M, Briggs P, Kelleher M. Restoration of a worn dentition using a double veneer technique. *Br Dent J* 1996; **180**: 26–29.
8. Watson IB, Tulloch EN. Clinical assessment of cases of tooth surface loss. *Br Dent J* 1985; **159**: 144–148.
9. Eccles JD. Erosion affecting the palatal surfaces of upper anterior teeth in young people. *Br Dent J* 1982; **152**: 375–379.
10. Milosevic A, Jones C. Use of resin bonded ceramic crowns in a bulimic patient with severe tooth erosion. *Quint Int* 1996; **27**: 123–127.
11. Bartlett DW, Coward PY, Nikkah C, Wilson RF. Prevalence of tooth wear in a cluster sample of adolescent school children and its relationship with potential explanatory factors. *Br Dent J* 1998; **184**: 125–129.
12. Lewis KJ, Smith BGN. The relationship of erosion and attrition in extensive tooth tissue loss. *Br Dent J* 1973; **135**: 400–404.
13. Smith BGN. Tooth wear: aetiology and diagnosis. *Dent Update* 1989; **16**: 204–213.
14. Jarvinen VK, Rytomaa II, Meurman H. Location of dental erosion in a referred population. *Caries Res* 1992; **26**: 391–396.
15. Smith BGN, Bartlett DW, Robb NG. The prevalence, aetiology and management of tooth wear in the United Kingdom. *J Prosthet Dent* 1997; **78**: 367–372.
16. Smith BGN, Knight JK. A comparison of patterns of tooth wear with aetiological factors. *Br Dent J* 1984; **157**: 16–19.
17. Bedi R. Dental management of a child with anorexia nervosa who presents with severe tooth erosion. *Eur J Prosthet Restor Dent* 1991; **1**: 13–17.
18. Milosevic A, Lennon MA, Fear SC. Risk factors

- associated with tooth wear in teenagers: a case control study. *Community Dent Health* 1997; **14**: 143–147.
19. Nunn J, Shaw L, Smith A. Tooth wear – dental erosion. *Br Dent J* 1996; **180**: 349–352.
 20. Smith BGN, Knight JK. An index for measuring the wear of teeth. *Br Dent J* 1984; **156**: 435–438.
 21. Bassiouny MA, Pollack RL. Aesthetic management of perimolysis with porcelain laminate veneers. *J Am Dent Assoc* 1987; **115**: 412–417.
 22. Walls AWG. The use of adhesively retained all porcelain veneers during the management of fractured and worn anterior teeth: part I clinical technique. *Br Dent J* 1995; **178**: 333–336.
 23. Dahl BL, Krogstad O, Carlsen K. An alternative treatment in cases with advanced localised attrition. *J Oral Rehabil* 1975; **2**: 209–214.
 24. Burke FJT. Treatment of loss of tooth substance using dentine bonded crowns: report of a case. *Dent Update* 1998; **25**: 235–240.
 25. Darbar UR. Treatment of palatal erosive wear by using oxidised gold veneers: a case report. *Quint Int* 1994; **25**: 195–197.
 26. Eccles JD. Tooth surface loss from abrasion, attrition and erosion. *Dent Update* 1982; **9**: 373–381.
 27. Bevenius J, L'estrage P. Chairside evaluation of salivary parameters in patients with tooth surface loss: A pilot study. *Aust Dent J* 1990; **35**: 219–221.
 28. Qualtrough AJE. Dentine bonded ceramic crowns: two case reports. *Br Dent J* 1997; **183**: 408–411.
 29. Bishop K, Briggs P, Kelleher M. The aetiology and management of localised anterior tooth wear in the young adult. *Dent Update* 1994; **21**: 153–160.
 30. Briggs P, Bishop K, Kelleher M. Management of tooth wear. *Br Dent J* 1996; **181**: 123.
 31. King PA. Adhesive techniques. *Br Dent J* 1999; **186**: 321–326.
 32. Briggs PFA, Bishop K, Djemal S. The clinical evolution of the 'Dahl principle'. *Br Dent J* 1997; **183**: 171–176.