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Tooth wear: A review

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Abstract--Tooth wear is the result of four processes: abrasion (wear produced by interaction between teeth and other materials), attrition (wear through tooth-tooth contact), abfraction and erosion (dissolution of hard tissue by acidic substances). A further process (abfraction) might potentiate wear by abrasion and/or erosion. Knowledge of these tooth wear processes, and their interactions is reviewed. Both clinical and experimental observations show that individual wear mechanisms rarely act alone but interact with each other. The most important interaction is the potentiation of abrasion by erosive damage to the dental hard tissues. Saliva can modulate erosive/abrasive tooth wear, especially through formation of pellicle, but cannot prevent it.

Keywords--bruxism, occlusal splints, tooth abrasion, tooth attrition, tooth erosion, tooth abfraction, tooth intrusion, tooth wear.

Introduction

The term ‘tooth wear’ describes all types of non-carious tooth substance loss.¹ This has been seen in archaeological artefacts, predating the appearance of caries, and can also be more difficult to prevent.¹ There are four types of tooth wear and these describe specific aetiological factors:

- Abrasion is tooth substance loss through abnormal mechanical processes that involve foreign objects or substances repeatedly introduced in the mouth and contacting the teeth. This is most attributed to tooth-brushing.¹

- Attrition is tooth substance loss resulting from tooth-to-tooth contact with no foreign substance intervening. ¹
- Erosion is tooth substance loss by a chemical process that does not involve bacteria and is not directly associated with caries or mechanical or traumatic factors. ²
- Abfraction is a term proposed to describe tooth substance loss by flexure and failure of tooth substance from occlusal loading at a location away from the loading, most typically the cervical enamel.²

Attrition

Attrition is formally defined as the loss of tooth substance caused by tooth-to-tooth contact so although it is predominantly seen occlusally, attrition can also occur interproximally as lateral movement of the teeth produces broader interproximal contacts over time.³



Fig.1-Attrition

Diagnosis

The signs and symptoms typically found in a patient presenting with attrition are outlined below.⁴

Symptom

- Tooth grinding at night⁴
- Jaw pain, fatigue and limited opening on waking
- Teeth feel loose (localised or generalised)
- Sore teeth or sore gums⁴
- Headaches in the temporal region
- Grinding or clenching of the teeth while awake. ⁴

Clinical signs

- Tooth wear and marked wear facets, particularly in protrusion or lateral excursion⁴

- Tooth fractures – natural teeth or restorations
- Tooth mobility
- Pulp necrosis – as loads cause limitation of blood supply⁴
- Traumatic ulcers
- Linear alba. ⁴

Aetiology

There are generally thought to be three principal theories regarding the aetiology of attrition. In addition, there may also be modifying factors (often lifestyle factors) present, such as bone chewing. ⁵

The theories of attrition are⁵:

- Functional theory
- Parafunction initiated by occlusal interferences
- Central nervous system aetiology⁵

Functional theory

This suggests that tooth wear occurs due to prolonged contact of the teeth and the patient having a broad envelope of function. The seminal work of Lundeen *et al.*⁶ showed that some patients exhibit a very extensive range of movement in their usual chewing pattern, analogous to a cow chewing which leads to attrition and tooth wear. ⁵

Parafunction initiated by occlusal interferences

The theory that parafunction can be initiated by occlusal interferences and therefore managed clinically by occlusal adjustments or extensive rehabilitations has been present in the literature for many decades. Unfortunately, the evidence in the literature does not support this theory. ⁵

Central nervous system aetiology

Over the last two to three decades it has become evident that the majority of bruxism is caused by a central nervous stimulus and a great deal of work in this area has been undertaken by Professor Gilles Lavigne and his co-workers at the University of Montreal. It appears that bruxism can occur either when the patient is awake (awake bruxism) or when the patient is asleep (nocturnal bruxism). ⁴

Modifying factors in attrition

- Ecstasy⁴
- Habitual chewing on hard food stuffs
- Selective 5-hydroxytryptamine reuptake inhibitors (SSRIs) ⁴
- Lack of posterior support⁴

Clinical management

Splints

The choice of splints available for bruxism patients are either hard splints, soft splints and, more recently, hybrid splints with a soft inner lining and a hard-outer shell. Splints can be used in either the upper or lower arch but there is little guidance in the literature as to which is best. Some clinicians believe it is potentially better to use a splint in the upper arch as the hard palate is available to distribute any occlusal loads more widely, but hard evidence for this recommendation is lacking.⁵

Hard (usually acrylic) splints can also be used to allow any spasm in the muscles of mastication to resolve, which will allow recording of the retruded contact position (RCP) more easily. In addition to this, a hard splint can also be used to reversibly assess any increase of the occlusal vertical dimension if this is thought necessary, although many clinicians will now only use a splint in this way if increases in OVD are large and in excess of 4–5 mm.⁵



Fig.2 Hard splint

Restoration

A popular technique for managing localised anterior tooth wear is the Dahl technique first described by Dahl and his co-workers in 1975.⁶ The main problem with tooth wear, including attrition, is that it usually takes place slowly⁷ with a typical loss estimated to be less than 15 microns per year. As a result of this, in most patients the teeth move into the space created by the tooth wear in a process known as compensatory overeruption.⁸ As a consequence the main issue in many tooth wear cases is a lack of space anteriorly in which to place restorations such as crowns.⁸

The Dahl technique was designed to overcome this problem by placing what was essentially a metal anterior bite raising platform which the patient wore for around 6–12 months.^{6,9} This bite platform causes disclusion of the posterior teeth and over a period of 6–12 months the posterior teeth erupt back into contact at an increased OVD dictated by the Dahl appliance. In addition to the posterior

tooth eruption, there is also an element of intrusion of the lower anterior teeth caused by the appliance.¹⁰



Fig.3 – Dahl Appliance

Abrasion

Friction between a tooth and an exogenous agent causes wear called “abrasion.” If teeth are worn on their occlusal surfaces, incisal surfaces or both by friction from the food bolus, this wear is termed “masticatory abrasion”¹



Fig.4-Abrasion

Aetiology

- Abrasive dentifrices⁴
- Brushing technique (mainly horizontal)
- Beetle nut habit⁴
- Occupational pipe smoking
- Pica
- Using teeth as tool⁴



Fig 5 – horizontal brushing technique

Management

Reducing the risk factors

Identification of the risk factor(s) is clearly important in order to modify any habits and provide appropriate advice. Questioning patients about acidic diet is covered elsewhere. Oral hygiene habits will involve detailed analysis of technique, frequency, types of brush and toothpaste. Certain pastes or powders are abrasive, such as smoker's powders. The distribution of abrasion defects will help the clinician diagnose the risk factors.¹¹

Desensitizing paste and resins

If the only complaint is of dentine sensitivity, then advice to use desensitising toothpastes or application of de-sensitising resin as appropriate. When applying resin, it is important to clean the surface with an oil-free prophylaxis paste and to follow the manufacturer's guidance. Self-etch resins such as Seal and Protect™ (Dentsply) require two to three surface coats for maximal benefit. Such resins have good retention and protect against wear in situ.¹¹



Fig 6- desensitizing resin

Restoration

There are various aesthetic restorative materials indicated for such cases, including glass-ionomer cements, composites and hybrids of these materials. The choice of material will depend upon clinical experience, the need to maximise aesthetics and whether fluoride release is important. Glass-ionomer cements are inherently adhesive, whereas composite systems require an etching and bonding stage. The release of fluoride is very advantageous. Glass-ionomers provide a sustained release over years and can absorb fluoride from the oral cavity for later release, thus acting as a storage reservoir.¹²

Composites do not have this ability, although the polyacid-modified resin composites or compomers have hydrophilic monomers, which allows water diffusion into the set material and fluoride ions out of the matrix. For anterior cervical lesions, where aesthetics needs to be optimal, a composite or compomer are appropriate. Since neither material is bulk set, light curing is needed through a transparent matrix, which will help provide the desired contour and reduce finishing time.¹²

Glass ionomers have the advantage of bulk placement and longer fluoride release, but they have low wear resistance, low toughness and dissolve in acids. If acid erosion is not controlled, then a composite or compomer may be better. Furthermore, the handling characteristics of glass ionomers are inferior to composite, with short working times and long setting times. This has been overcome to some extent by the development of resin-modified glass ionomers which can be command set by light and have improved resistance to desiccation and acid attack.¹²

Erosion

Dental erosion is defined as irreversible loss of dental hard tissue by a chemical process that does not involve bacteria. Dissolution of mineralized tooth structure occurs on contact with acids that are introduced into the oral cavity from intrinsic (e.g., gastroesophageal reflux, vomiting) or extrinsic (e.g., acidic beverages, citrus fruits) sources. This form of tooth surface loss is part of a larger picture of tooth wear, which also consists of attrition, abrasion, and, possibly, abfraction.¹³

Aetiology

Extrinsic factors¹⁴

- ACIDIC BEVERAGES
- CITRUS FRUIT
- DIETRY ACID
- MEDICATIONS

Intrinsic factors^{15,16}

- GERD
- SALIVA

- VOMITING

Management

Prevention

Since risk factors relate to diet and behaviours, lifestyle change is important. Dentists must question patients closely yet sympathetically about their consumption of a range of potentially erosive drinks and foods, and related habits. Often aetiological factors are not readily identified, either because the patient is unaware what they might be, or they may have unrecognised gastric reflux (silent GERD), or be unwilling to disclose through embarrassment an eating disorder.¹⁰

- Cut down on frequency of intake¹⁰
- Drink alternatives (water, diluted squash, milk, tea)
- Dilute drinks¹⁰
- Don't swish, froth, sip or hold drinks in the mouth
- Use a wide-bore straw placed at the back of the mouth
- Chill the drink
- Don't drink at night or bedtime¹⁰

Conservative management of dental erosion:

- Fluoride mouth rinse
- Fluoride toothpaste specifically for erosion
- Desensitising toothpaste¹⁰
- Application of CPP/ACP
- Sugar-free chewing gum – or any other appropriate method to improve salivary clearance and flow (fruit flavoured variants are acidic)
- Application of desensitising resin – not only to eroded areas but also on susceptible surfaces¹⁰

Restoration

Erosion limited to labial and buccal surfaces – no increase in OVD

A pseudo chamfer maybe visible within enamel and the lesion is broad and shallow. Appearance was an issue and both patients requested treatment. The first step was to identify the risk factors and modify them. Restoration using composite was easy and simple. If sensitivity is present and appearance is not an issue, application of a desensitising unfilled resin is indicated. These are self-etch resins which, as with all resins, should be applied to a clean and salivary pellicle-free surface. Oil-free prophylactic paste rather than pumice is preferable, as pumice particles can remain on the surface. Care to avoid contamination with saliva is important once the surface is cleaned, followed by immediate placement of the resin. Two to three layers of resin need to be applied and separately cured onto the eroded surface to gain relief of symptoms.^{12,17}

Erosion limited to palatal surfaces only – space present, no increase in OVD

Depending on whether there is sensitivity or discomfort, restoration may be avoided. It is acceptable to leave exposed dentine as the tubules are, or will become sclerosed with peritubular dentine which is hyper mineralised compared to inter tubular dentine.¹⁵ The dentine appears glassy and hard. In this clinical situation, a check for any clearance between the upper and lower incisors must be assessed whilst in ICP. If space is present, restorative treatment should be straightforward as encroachment into the occlusal vertical dimension is not indicated. Bonding composite directly onto the palatal surfaces is probably the simplest and easiest treatment option, although composite tends to bond to adjacent tooth substance across the contacts, unless acetate strips or lengths of PTF ('plumber's') tape are placed interdentially.¹⁷

Erosion limited to palatal surfaces only – insufficient or no space, increase in OVD needed

When there is no space between the short and worn anterior teeth because of dento-alveolar compensation, it is appropriate to gain space using the Dahl approach.¹⁷ The original concept used a removable upper anterior bite platform to depress or intrude the lower anterior teeth and allow eruption of the posterior teeth, termed relative axial tooth movement. Immediately upon insertion of the platform, the posterior teeth are taken out of contact, typically by about 2mm, but over an average of six months these teeth closed together to re-establish contact at the increased OVD. Initial suggestions that this was orthodontic movement were discounted by follow-up studies.¹⁸

Abfraction

Abfraction, as defined by Grippo, is the pathological loss of tooth substance caused by biomechanical loading forces that result in flexure and failure of enamel and dentin at a location away from the loading.¹⁹ The term is derived from the Latin words 'ab,' or away, and 'fractio,' or breaking by J. O. Grippo. ¹⁹



Fig.7-Abfraction

Theory of abfraction

The theory of abfraction is based primarily on the relationship between occlusal loading and stress concentration in the cervical region of tooth. Various research on this relationship concludes that teeth do flex in the cervical region under bruxing loads, but none seems to cite actual damage caused only by this loading alone but hypothesized that this deformation was occurring in combination with the abrasive or erosive component as well.²⁰

Management

The most important criterion for restoration is that of retention. Clinical studies have shown that restorations of abfraction lesions have a higher percentage of failure in the cervical area due to popping out effect caused by parafunctional habits. As these lesions implicate enamel and dentine margins, they represent a challenge to the dental profession.¹² When abfraction lesion is less than 1 mm in depth²², only monitoring at regular intervals is enough. Restoring these lesions improves the maintenance of oral hygiene of the patient. It also helps in decreasing thermal sensitivity, improving aesthetics, and strengthening the teeth.¹⁹ Along with restoration, a variety of treatment strategies have also been proposed like occlusal adjustments, occlusal splints, elimination of parafunctional habits, altering toothbrushing techniques, etc^{19,20,21}

Restorations

For restoring abfractions, various materials have been tried to date. These include glass-ionomer cement (GICs), resin-modified GICs (RMGICs), polyacid-modified resin-based composites (compomers), composite resins and a combination of the techniques. Tyas et al. said that Resin modified glass ionomer cement (RMGIC) should be the first preference. RMGIC/GIC liner or base with resin composite should be used wherever aesthetics is concerned. Two different techniques either etch-and-rinse technique or self-etch technique have been employed for restoring these lesions. The main reason for the failure of restoration is difficulty in gaining and maintaining a good seal between the restoration and tooth at the margin. The retention rate for restorations with a lower elastic modulus may be significantly better than a material with a higher elastic modulus. Heymann et al. reported the association of occlusion, tooth location, patient's age with loss of retention while others blame technique, marginal shrinkage, properties of bonding agent, and inadequate adhesive resin thickness for the retention loss.^{19,20,21}

Root coverage surgical procedures:²²

- Done when abfraction along with gingival recession is present
- It's a combined restorative surgical approach
- Firstly, restoration is done before the surgical part as it provide better visibility, stable hard and convex substrate for coronally advanced flap (CAF)²²

Conclusion

Dental professionals have an important obligation in preventing, managing and monitoring tooth wear in patients affected by or predisposed to the condition, and dental technology has a vital role in this. In addition to providing dental study models and digitised models for monitoring tooth wear, correctly utilised dental appliances and restorations can play a valuable part by protecting the teeth from further wear and restoring severely affected teeth. Dental appliances also have a role in helping to produce the essential inter-occlusal space required for restorations in patients with significant tooth wear and providing surgical templates where surgical crown lengthening is required.

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