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Introduction and the Prevalence of Tooth Wear

1.1 Introduction

There are increasing concerns over the levels of non-carious tooth surface loss being encountered amongst patients attending for routine dental examinations in general dental practice.[1] Indeed due to its prevalence, it has become common practice (in at least some countries) to carry out risk assessments for the presence of tooth wear (TW) as part of the overall process of performing the accepted assessments and evaluations during a dental examination.[2]

Given the frequent and varied range of physical, mechanical, and chemical challenges faced by human dentition on a daily basis, the irreversible wearing-away of the dental hard tissues can be assumed to most likely occur as a result of the natural ageing process. Consequently, TW is a 'normal' physiological process and differs somewhat from a number of the other oral diseases that are also routinely screened for such as dental caries, periodontal disease or oral mucosal conditions, which are all by definition pathological processes. Difficulty may, however, be encountered in attempting to determine the clinical distinction between TW that may be considered representative of the consequences of the natural ageing process, commonly referred to as physiological wear, and an appearance worthy of a diagnostic entity. It is therefore important to consider some of the key terms and definitions in relation to the irreversible wearing-away of tooth tissue, and to further explore some of the ambiguities and confusion that surrounds the application of these terms.

The term *tooth wear (TW)* is a general term that can be used to describe the surface loss of dental hard tissues from causes other than dental caries or dental trauma.[3] Usually, TW is subdivided into subforms, such as *attrition*, *abrasion*, and *erosion*, in accordance with the suspected/known aetiology. Whilst these aetiological factors can sometimes occur in isolation, clinically it is difficult (if not at times impossible) to identify a single causative factor when a patient presents with TW as the condition more often than not has a multifactorial aetiology. For this reason, the term *tooth surface loss (TSL)* was suggested by Eccles in 1982 to embrace all of the aetiological factors regardless of whether the exact cause of wear has been identified.[4]

Given the above, the authors have a preference towards a subdivision that indicates that there is a combination of factors that lead to tissue loss. Accordingly,

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the nature of dental wear may be broadly divided into *mechanical wear* and *chemical wear,* and both forms further subdivided into *intrinsic and extrinsic*, with the overall existence of four subforms, hence:

- *mechanical intrinsic TW* (as a result of chewing or bruxism, also called *attrition*)
- *mechanical extrinsic TW* (due to factors other than chewing and/or bruxism, also called *abrasion*, for example with a toothbrush)
- *chemical intrinsic TW* (as consequence of gastric acid, also called *erosion*)
- *chemical extrinsic dental wear* (as a result of an acidic diet, also known as *erosion*).

Unfortunately, there is considerable ambiguity with the application of some of the above terms (nationally and internationally) that renders effective communication between healthcare providers challenging, especially when attempting to draw comparisons between differing items of dental research.

It had been proposed by Smith et al.[5] that the use of the term TSL may inadvertently imply an under-estimation of the actual extent and severity of the problem by suggesting the condition to only refer to the surface (or superficial) loss of tooth tissue (as opposed to the additional subsurface loss), which is often seen clinically, thereby failing to take into account cases of more extensive tooth tissue loss. Consequently, they have suggested that the use of the term TW be preferred where there may be inadequate evidence to strongly support the cause of wear being a result of erosion, attrition or abrasion (so as to facilitate the process of communication between dentists and with their patients).[5] As a result, the authors do not recommend use of the term *erosive tooth wear* (as is often evidenced in many scientific publications), as this implies that erosion is the primary aetiological factor.

1.2 Physiological Wear and Pathological Wear: The Concept of Severe Tooth Wear

It has been suggested that as teeth continue to function and thus remain continually exposed to erosive, abrasive, and attritive factors, the wearing-away of tooth tissue will probably occur as an age-related phenomenon.[6]

A number of reports have been published describing the rates of TW progression. Lambrechts et al. have estimated the normal vertical loss of enamel from physiological wear to be approximately 18 µm for premolar teeth and 38 µm for molar teeth, respectively, per annum.[7] Comparable rates of progression have been reported in a more recent study by Rodriguez et al.[8] With specific reference to incisor teeth, by the means of undertaking a cross-sectional digital radiographic study to estimate the rate of incisor TW amongst 346 subjects Ray et al. have reported the average crown height of a maxillary central incisor to decrease by 1.01 mm (approximately 1000 µm) from 11.94 mm between the age of 10 years to 70 years, and for mandibular central incisor teeth, the average crown height to decrease by 1.46 mm (approximately 1500 µm) to 9.58 mm over a period of six decades (when applying the same age

ranges), representing the mean annual wear rates of central incisor teeth to be in the range of 17–25 μm per year of life.[9]

The term *physiological wear* (Figure 1.1) is thus commonly applied to describe that level of TW observed which is expected for the patient's age, commensurate with normal day-to-day function.[10]

Historically the term *pathological wear* (Figure 1.2a–d) was used to relate to the presence of unacceptable wear for a particular age group based on clinical judgement and has been traditionally applied as describing a level of wear when restorative intervention may be justified. However, the use of clinical judgement clearly does not permit an accurate and consistent approach as this would require the concomitant need to define the precise 'normal levels of wear' (that should be present in differing age groups and populations), as well as the availability of a reasonably accurate and consistent method to measure the levels of wear actually present. Given the current lack of knowledge in relation to the pathogenesis of TW (with two common theories being described, one of slow cumulative progression occurring throughout life – often referred to as *continual* and the alternative of cyclical bursts of activity – commonly termed *episodic*),[6] it would be very difficult to determine meaningful benchmark values for the levels of TW likely to be present amongst individuals of differing ages.[6]

In 2017, in an attempt to improve clarity and understating, the term *pathological wear* was defined in a European Consensus Statement on the Management Guidelines (for Severe Wear) as 'tooth wear which is atypical for the age of the patient causing pain or discomfort, functional problems, or deterioration of aesthetic appearance, which if it progresses, may give rise to undesirable complications of increased complexity'.[11] However, ambiguity is still likely to remain for the reasons discussed above.

It has therefore been suggested that the diagnostic entity of *severe tooth wear* may be more appropriate when undertaking clinical assessments. The latter term has been defined as 'tooth wear with substantial loss of tooth structure, with dentine exposure and significant loss (more than or equal to one third) of the clinical crown.'[11] The presence of severe wear can be used to define the highest grade of a clinical index, which in turn may be used to screen for the extent and severity of TW present, in a manner similar to other indices and monitoring tools used in clinical dentistry (Figure 1.3).

However, the use of an index based on the severity of TW observed clinically may be of limited merit in identifying treatment need. This can be illustrated by the example of the case of a young patient, seen in Figure 1.4, diagnosed with erosive pathological TW on the palatal surfaces of the maxillary central incisor teeth by virtue of the level of wear clinically present. In addition there are symptoms of sensitivity and an aesthetic impairment. However, with the absence of less than one-third clinical crown loss, severe wear (by definition) may not be present in this case, although active restorative intervention would likely be indicated. In contrast, signs of severe wear may be seen to exist in an 89-year-old (see Figure 1.5), but in this case there would be no clear indication to provide any forms of active restorative intervention.

The use of indices for TW is discussed further in Chapter 3.

1.3 The Prevalence of TW

In relation to the matter of the prevalence of TW (amongst adult dentate patients), the 2009 UK Adult Dental Health Survey (ADHS) reported:[12]

- 77% of the 6469 adults examined showed some signs of TW in the anterior teeth (compared with 66% in 1989), with the type of wear described as being consistent with normal ageing with the exposure of dentine on the incisal tips
- 15% displayed signs of moderate wear (presenting with more extensive dentine exposure) and 2% severe TW (with the level of presenting hard tissue wear extending as far as secondary dentine)
- the damage was cumulative, with an increased prevalence with age and with more than 80% of the over-50-year-olds exhibiting some TW, but an increasing proportion of moderate wear amongst younger adults – likely to be clinically important
- TW was more prevalent amongst males (71% versus 61% for females)
- signs of moderate TW increased by 4% between 1998 (11%) and 2009 (15%)
- although severe TW remains relatively rare, the incidence had increased since the previous survey in 1998.

Given an ageing Western population retaining its natural teeth into advanced years, supported by a progressive decline in the number of edentulous patients as highlighted in the 2009 UK ADHS (with a 22% reduction in the proportion of such patients since 1978), it is hardly surprising to see signs of TW amongst older patients. Such teeth will have been exposed to a plethora of elements that may lead to wear by intrinsic and extrinsic factors over a sustained period spanning several decades.

As part of a systematic review of the results of 186 prevalence studies of TW by all causes, it was concluded that the percentage of adult patients presenting with severe TW increased from 3% at the age of 20 years to 17% at the age of 70 years, with a tendency to develop more wear with age.[13] The results of a large epidemiological study amongst German dental patients reported similar results, where the extent of TW was scored on a scale from 0 to 3 (with higher scores indicating more severe levels of TW), with mean wear scores increasing from 0.6 amongst 20–29 year olds to 1.4 in 70–79 year olds.[14]

There also seem to be variations in the incidence rates of TW amongst patients residing in different European countries, with the highest level of wear rates being reported in the UK.[15] The latter has been possibly accounted for by risk factors such as heartburn, acid reflux, repeated vomiting, and acidic intake, especially related to the consumption of fresh fruit and isotonic/energy drinks (as discussed further in Chapter 3). This study also showed approximately 30% of the subjects to demonstrate visible signs of TW, with evidence of a moderate rise in TW with increasing age, and a prevalence of severe wear being reported amongst 3% of the subjects included.

Whilst the criteria applied for identifying and scoring TW show wide variation amongst different studies, there has been considerable interest in studies documenting the prevalence of erosive TW, as it would appear that there has been a considerable increase in the incidence of erosion-related TW amongst children and young adults over the course of the past three decades.

Erosion was initially included in the UK Children's Dental Health Survey in 1993.[16] When reassessed in 1996/1997, a trend towards a higher prevalence of erosion in children aged between 3.5 years and 4.5 years (Figure 1.6) was identified (particularly amongst those children who consumed carbonated drinks on an almost daily basis when compared to toddlers consuming these drinks less frequently).[17] The initial Child Dental Health Survey also reported 25% of 11-year-olds and 32% of 14-year-olds assessed in their sample as showing signs of erosion affecting the palatal surfaces of their maxillary incisor teeth (which in more severe cases had progressed to involve the dentinal tissues and in some cases the pulp complex). It also revealed that almost half of the 5- and 6-year-olds studied demonstrated signs of erosion affecting the primary dentition, with almost 25% showing signs of dentinal or pulpal tissue involvement.

In another extensive UK-based study in 2004, in which 1753 children were examined at the age of 12 years and observed for a period of two years thereafter, 59.7% were reported to have evidence of TW at the commencement of the study, of which 2.7% had dentine exposure, which rose to 8.9% over the course of the two-year observation period.[18]

In the Netherlands, a survey amongst 622 children performed by El Aidi et al.[19] found that significant erosive wear was present in 1.8% of the 11-year-olds and 23.8% of the 15-year-olds. The incidence of new tooth surfaces exhibiting erosive wear, in erosion-free children, decreased significantly with age. In children with tooth erosion the condition progressed steadily. Therefore, it is likely that TW is an increasing problem amongst younger individuals but limited to specific risk groups.[20]

Erosive TW is caused by acidic substrates that may be either of an intrinsic origin or an extrinsic source. The consumption of soft drinks in the UK has been reported to have increased by sevenfold between the 1950s and 1990s, with adolescents and children accounting for 65% of all purchases, and a per capita intake of 15 l per person.[21] Likewise, soft drink consumption has also been reported to have increased in the USA by 300% over a period of 20 years, with serving sizes increasing from 185 g in the 1950s to 570 g in the late 1990s.[22] Table 1.1 lists the typical pH values of some commonly consumed beverages, as well as details of some of the acidic content.

Table 1.1 The pH values of commonly consumed beverages.

Beverage	Type	pH value (SD)
Pepsi-Cola	Diet	3.02 (0.01)
Coca Cola	Classic	2.37 (0.03)
Coca Cola	Caffeine-free, diet	3.04 (0.01
Red Bull	Sugar Free	3.39 (0.00)
Fanta	Orange	2.82 (0.02)
Orange juice	Minute Maid	3.82 (0.01)
Orangeade	Minute Maid	2.85 (0.00)

Other factors which may be responsible for the high rates of erosive TW described by the above studies include regurgitation, which may be either involuntary, associated with conditions such as hiatus hernia, or voluntary, as seen amongst patients presenting with eating disorders such as anorexia nervosa or bulimia nervosa.[23] Dental erosion may also be induced by environmental influences, such as that seen amongst those workers exposed to acids in the workplace.

A knowledge of the at-risk groups can help to target treatment and, in particular, preventative care. However, targeting at-risk groups is challenging in itself, as no clear definitions have been described. Given the effects of erosive damage on the permanent dentition of teenagers and younger adults, with the increased risk for needing repetitive and invariably costly restorative care, the importance of focussing on and delivering effective prevention for such groups is further highlighted, and is discussed in more detail in Chapter 7.

1.4 An Overview of the Challenges Associated with TW

The management of a patient presenting with TW is by no means always a straightforward matter, often requiring specialist attention where complex restorative care may be indicated for more severe cases. However, given that patients are increasingly presenting with signs of tooth tissue loss to their general dental practitioner, it is likely that the latter will have to acquire the necessary skills and knowledge to effectively care for and provide appropriate management in the primary care setting.

Aspects that may compound difficulties associated with TW management include:[24]

- the general lack of widespread awareness of TW amongst the public
- the lack of knowledge concerning the pathogenesis of TW
- challenges associated with deriving an accurate diagnosis, inclusive of the limitation of the available diagnostic methods and the confusion surrounding key diagnostic terms
- how to best deliver effective preventative care and implement monitoring strategies
- uncertainties in knowing at which precise stage to implement active restorative intervention (as opposed to simple passive management and monitoring strategy)
- a lack of understanding on how to predictably restore such severely worn dentitions, with the aim of ultimately attaining a functionally and aesthetically stable restored dentition
- a lack of knowledge relating to the availability of contemporary materials and their respective techniques of application.

These matters will be addressed in this textbook and the accompanying videos.

1.5 Conclusion

A clear understanding of the terminology, prevalence, and aetiological factors associated with TW is an important prerequisite to developing an effective strategy to manage patients who present with this condition. Subsequent chapters and the videos will elaborate further on the various aspects relevant to this topic.

Figure 1.1 Physiological TW in a 76-year-old male.

Figure 1.2 A patient in his mid-30s with pathological TW.

Figure 1.3 The upper teeth shown in a patient with severe TW. There is substantial loss of tooth structure, with dentine exposure and significant loss (more than or equal to one-third) of the clinical crown seen in the premolars and the upper first molars.

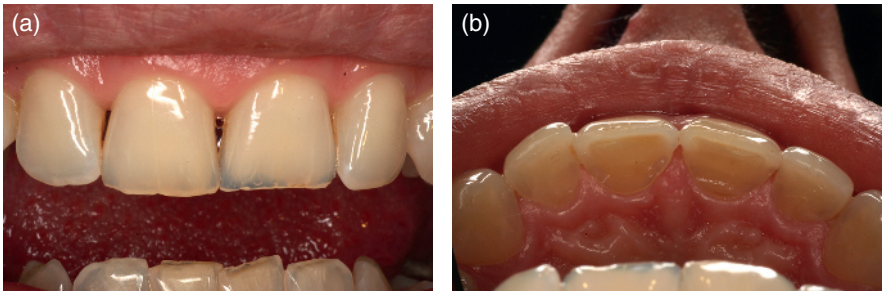

Figure 1.4 Pathological TW affecting the palatal surfaces of the upper central incisors. Patient complains of an aesthetic impairment and tooth sensitivity from these central incisors.

Figure 1.5 Severe TW depicted in this 89-year-old patient on the upper left lateral incisor and canine teeth.

Figure 1.6 Erosive TW in the primary dentition.

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