The incidence of tooth wear is an increasing problem faced by the dental profession (Spijker et al, 2009). According to the 2009 Adult Dental Health Survey (published in 2011), in England alone, the percentage of the adult dentate population showing signs of tooth wear has increased from two thirds (66%) to three quarters (76%) in 10 years. But what is more concerning is that the increase in the prevalence of tooth wear in this population was shown to be greatest in the younger age group of 16-34-year-olds, which is indicative of pathological, not age-related, tooth wear.

The main challenge facing the restorative dentist is to replace the lost hard tissue without removing further healthy tooth structure, giving the patient back an aesthetic, functional and durable dentition.

Tooth wear
Tooth wear has been classified into three categories – attrition, erosion and abrasion. Despite each classification having a unique presentation, the disease process of tooth wear has been shown to be of multifactorial aetiology (Dietschi, Argente, 2011; Litonjua et al, 2003).

The causative factors often involve systemic and centrally mediated pathways (gastro-oesophageal reflux disease, bulimia nervosa, bruxism), which can rarely be successfully or permanently eliminated, despite the implementation of preventive regimes (Milosevic, 1999; Bartlett et al, 1996; Klasser, Greene, Lavigne, 2010). So, if we are aware that prevention and absolute stabilisation of the disease process is a challenge, when should active restorative intervention be embarked upon?

Several classifications and indices have been devised to aid in identification of tooth wear and provide guidelines of when restorative intervention is appropriate. Until recently, these indices seemed to focus more on prevention and monitoring (perhaps primarily for epidemiological purposes), and only really indicated restorative intervention in severe cases when a large amount of tooth tissue had already been lost (Smith, Knight, 1984; Bartlett, Ganss, Lussi, 2008).

In a disease process where the clinician is aware of the continual loss of tooth structure from non-carious processes, this passive approach early on seems counterproductive. A more proactive approach, which is outlined by Vailati and Beber (2010) through their presentation of the anterior clinical erosive (ACE) classification, is more attractive. They advise: ‘Intercepting patients at the initial stages of the disease to avoid significant irreversible damages to their dentition and to benefit from still favourable conditions when it comes to clinical performance of the restorative measures proposed’.

The main challenge in the treatment of the worn dentition is the lack of restorative space that is encountered. Despite the loss of occlusal tooth structure, dento-alveolar compensatory processes result in the maintenance of the occlusal vertical dimension (OVD) (Berry, Poole, 1976). The primary options available to create the space required for the restorative material are:

- Increasing the OVD (within aesthetic and functional limits)
- Reduction of the existing tooth structure (often augmented with crown-lengthening procedures and/or elective endodontics).

The reality, especially in generalised wear cases, is that more often than not a
combination of the two modalities is applied to create restorative space.

The OVD is almost always increased in the management of compensated wear cases, and some occlusal tooth reduction of the posterior teeth is often needed. Orthodontic tooth movement can also be used to help with levelling of disrupted occlusal planes, creating favourable anterior tooth relationships and other localised tooth movements as part of the overall treatment plan.

**Adhesive dentistry**

The teeth can be restored with either traditional or adhesive restorations. Adhesive dentistry lends itself particularly to the restoration of the worn dentition. Conventional techniques involving traditional tooth preparations with maximal resistance and retention form can be unnecessarily destructive of the remaining sound tooth structure.

It has been shown that full coverage tooth preparations for full metal, metal-ceramic or all-ceramic crowns can result in up to 72% removal of coronal dentine in anterior teeth, and 75.6% in posterior teeth. This is significantly higher than the 3-30% removal of coronal dentine for adhesive tooth preparations (Edelhoff, Sorensen, 2002a; Edelhoff, Sorensen, 2002b).

Confidence in enamel bonding, as well as novel techniques to improve dentine bonding – such as immediate dentine sealing (Magne, 2005) – mean that restorations can be bonded onto teeth with a high level of predictability. However, this does not advocate dismissal of biomechanic prosthodontic principles. Care must be taken to design an occlusal scheme that allows for optimal loading of the restorations and the supporting teeth, in turn placing the least possible stress on the adhesive bond, which is likely to be the weakest link in the system (Van Meerbeek et al, 2006).

**Material selection**

Many restorative materials have been advocated for the adhesive restoration of tooth wear; the earliest being cast metal restorations designed with minimal preparation and adhesively bonded to the tooth. These restorations have proven to be a predictable and durable option, with excellent mechanical properties and allowing for accuracy and precision with occlusal control (Darbar, 1994; Husmann, Irwin, Kime, 1994; Nohl et al, 1997). However, they can compromise the aesthetics, and this has led to the employment of tooth-coloured restorations in the management of localised and generalised wear cases.

Much research has been carried out on the use of direct and indirect composite resins such as Dahl type appliances for the restoration of localised anterior tooth wear (Poyser et al, 2007; Gough, Satchell, 1999; Gow, Hemmings, 2002; Hemmings, Darbar, Vaughan, 2000; Redman, Hemmings, Good, 2000; Gulamali et al, 2011). This work has shown good short- to medium-term survival when used to restore localised anterior tooth wear, as well as supporting the Dahl concept (Dahl, Krogstad, Karlsten, 1975; Dahl, Krogstad, 1982).

The median survival time reported from a prospective 10-year follow-up of such restorations from a single centre was seven years. The main causes of failure with restorations requiring complete replacement were documented as wear, fracture or discolouration of the restorations. However, it was noted that repairs/replacements were readily carried out, and biological complications (secondary caries) only affected 2% of the restorations (Gulamali et al, 2011).

In vitro studies have investigated the use of CAD/CAM composite resin to restore the occlusal surfaces of severely worn posterior teeth. These studies have shown extremely promising results, with very thin (0.6mm) milled occlusal composite veneers being able to withstand cyclic loading up to 1400N (Schlichting et al, 2011; Magne, Stanley, Schlichting, 2012).

Additionally, prospective clinical trials are currently being carried out by Vailati and Belser (2008a, 2008b, 2008c) and co-workers on the use of composite resins for the full mouth rehabilitation of severe wear cases.

The long-term data to support the use of bonded ceramic materials for the restoration of the articulating surfaces in wear cases is limited, and commonly presented only as case reports (Mizrahi, 2008; Fadeani et al, 2012). However, work by Magne and his team has shown promising results in vitro with CAD/CAM occlusal restorations fabricated from lithium disilicate blocks being able to withstand fatigue testing up to 800N (Schlichting et al, 2011; Magne, Stanley, Schlichting, 2012).

Selection of the restorative material should be based upon the aetiology of the wear, the amount of remaining tooth structure, the restorative space available, the design of the occlusal scheme, the plan for the opposing dentition (differential wear) and the aesthetic requirements.

**Clinical case report**

The following case illustrates the use of direct and indirect composite resin to restore a dentition with generalised tooth wear.

The patient was a healthy 35-year-old male. His presenting complaint was the appearance of the worn front teeth and, being a dentist himself, he was aware of the wear on the posterior teeth as well (Figure 1).

Upon examination, severe tooth wear was noted on the palatal and incisal surfaces of the maxillary anterior teeth, as well the incisal surfaces of the mandibular anterior teeth. The posterior teeth exhibited similar wear patterns, but of reduced severity, on the occlusal surfaces, resulting in notable loss of posterior occlusal anatomy.

These lesions were consistent with combined erosive and attritional aetiologies. The teeth were otherwise unrestored. The patient had good oral hygiene and good periodontal health, and no associated endodontic pathologies (Figures 1-4).

Occlusal analysis revealed a stable intercuspal position (ICP). There was shallow anterior guidance in excursive movements, with minimal posterior discusion. A small discrepancy of approximately 1mm horizontal (anterior-posterior) and 1mm vertical (incisal-apical) exists.

The decision was made to fabricate a comprehensive restoration. Occlusal restorations were fabricated from lithium disilicate blocks using CAD/CAM technology (Vailati et al, 2012). This tooth-by-tooth approach allowed for accurate and precise positioning of the restorations, minimising the potential for further tooth wear.

**FIGURE 1**

A 35-year-old male patient with severe tooth wear. The patient had good oral hygiene and good periodontal health, and no associated endodontic pathologies. Occlusal analysis revealed a stable intercuspal position (ICP). There was shallow anterior guidance in excursive movements, with minimal posterior discusion. A small discrepancy of approximately 1mm horizontal (anterior-posterior) and 1mm vertical (incisal-apical) exists.
vertical dimensions was noted between centric relation (CR) and maximum intercuspation (MI), with MI being slightly anterior to CR. The occlusal planes were fairly flat, with no disruptions. Additionally, the OVD did not appear to be decreased.

Upon questioning, the patient revealed that he used to consume a large quantity of carbonated drinks, which we both believed to be the primary causative factor of the wear. The patient assured me, and analysis with a diet diary revealed, that his diet no longer included highly acidic foods. He was given counselling and advice on his diet and oral hygiene regimes.

The use of amorphous calcium phosphate stabilised in casein phosphopeptides (GC Tooth Mousse) was also incorporated into his preventive regime, as this has been shown to be highly effective in encouraging calcium and phosphate uptake into the dental hard tissues, promoting remineralisation (Reynolds, 1997; Cochrane et al, 2010).

The primary aim of treatment was to restore the aesthetics and function of the worn dentition. This was achieved by restoring the length of the maxillary and mandibular anterior teeth to recreate the aesthetics of the patient’s smile and, within the limits of the newly achieved anterior overlap, restoring the articulating surfaces of the anterior and posterior teeth to provide a mutually protected occlusion. The dentition was reconstructed at an increased OVD using CR as the working jaw relationship.

**Diagnostic wax-up and mock-up**

A diagnostic wax-up was carried out to envisage final form and function of the proposed aesthetic and occlusal rehabilitation. This stage is of paramount importance in adhesive cases, primarily because there is limited scope for testing the final restorations in a provisional phase. Therefore, accuracy and attention to detail at the diagnostic wax-up and mock-up stages is essential.

The diagnostic wax-up was carried out on study casts mounted on a semi-adjustable articulator in CR. The initial wax-up focused on the articulating and vestibular surfaces of the maxillary and mandibular anterior teeth. The decision was made on how much to increase the OVD based on a combination of aesthetic and functional requirements.

The wax-up was also duplicated and modified by adding wax over the vestibular surfaces of the maxillary anterior teeth to establish whether the ‘sandwich technique’ (composite palatal veneers and ceramic labial veneers) as described by Vailati and Belser (2010; 2008) could be applied in this case for an ideal aesthetic outcome (Figures 5 and 6).

Both wax-ups were mocked up in the mouth using a bisacryl temporary crown material and silicone keys taken directly from the wax-ups. An assessment was made of the aesthetics, the envelope of function provided by the anterior guidance, the space available for restoration of the posterior teeth, and the phonetics.

The patient opted not to have the maxillary anterior teeth restored with additional labial ceramic veneers at this stage, although it was made clear that this option was still feasible in the future (Figures 7 and 8).

The anterior diagnostic wax-up was duplicated, and the posterior teeth were then waxed-up to provide ideal posterior occlusal anatomy within the confines of the newly designed anterior guidance. Only minor additions were required to the maxillary posterior teeth, but full occlusal coverage was required on the mandibular posterior teeth to ensure a fairly level occlusal plane.

Having verified the diagnostic wax-up, the next stage was to select which restorative materials were most suitable for the case. It was decided that an additive and adhesive approach would be applied to conserve maximum tooth structure, as opposed to preparing any teeth for conventional crowns. The restorative materials considered were composite resin, cast gold and ceramic. The final choice was a combination of direct and indirect composite resin. Ceramic was not used in this case because of the noted attritional element of the wear and concerns with a low strength etchable ceramic in a potential parafunctional patient. It was suggested to the patient to place cast gold palatal veneers on the upper canine teeth and adhesive gold onlays on the lower second molar teeth to allow for maintenance of occlusal stability. The patient declined this option because of aesthetic concerns.

**Summary**

The treatment planning and diagnostic protocols employed in the management of a worn dentition have been described in detail, and illustrated with a clinical case. These stages are of particular importance in being able to achieve a predictable and successful outcome.

Part two will outline the clinical techniques used in the restoration of the worn dentition with direct and indirect composite resin.

**Further information**

The author would like to thank dental technician Mr Jacques-Antoine Tribault for his skill and expertise in the production of all of the laboratory work shown.

For the list of references that accompany this article, please email pd@fmc.co.uk.

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