

The management of tooth wear with crowns and indirect restorations

S. Varma,^{*1} A. Preiskel¹ and D. Bartlett¹

Key points

The rationale for using crowns when composites continually fail.

Indications and management for crown lengthening of worn teeth.

Material options for definitive crowns in the treatment of tooth wear.

This manuscript summarises the reasons behind choosing indirect restorations in the treatment of tooth wear. The purpose of this article is to discuss the use of crowns as a restorative treatment option for tooth wear. There are also challenges with the use of composites as they can repeatedly fail and in these situations the indications for crowns for treatment of tooth wear is worthy of consideration. This article is part of a themed issue discussing the management of tooth wear.

Introduction

Tooth wear is a multifactorial disease, and the risk factors, prevention and management with composite resins have been discussed in previous papers.¹⁻³ The purpose of this article is to discuss the use of crowns as a restorative treatment option for tooth wear. There are also challenges with the use of composites as they can repeatedly fail and in these situations the indications for crowns⁴ for treatment of tooth wear is worthy of consideration.

The major indicators for operative intervention are aesthetics and protection from future wear. It is unlikely that providing direct or indirect restorations will prevent sensitivity unless preventative measures such as desensitising agents are utilised. A recent European consensus meeting discussed the management of severe tooth wear.⁴ The consensus report suggested that restorative care should be delayed as long as possible and that if indicated minimal intervention should be the first port of call. The consensus report has also recognised that management decisions are multi-factorial and depend on the severity of disease as well as

the wishes of the patient. It is the wishes of the patient in conjunction with previously failed composites that can lead onto treatment with crowns (Fig. 1).

Composites vs crowns

The use of full coverage crowns could be considered a controversial intervention as it involves preparation of tooth structure for teeth that have already lost volume due to wear. Direct composite build ups have advantages as they do not require preparation, can be easily adjusted and are considered by some to be reversible. A recent systematic review⁵ reported the results of studies utilising composite for the treatment of wear. This review mainly concentrated on direct composites, indirect composites and porcelain veneers, and reported that neither material performed better than another. This review did not include studies of full coverage crowns. Another study by Milosevic⁶ showed favourable long term results with direct composites in tooth wear treatment but were all placed by a single operator. However, extensive direct composite restorations are time consuming and can be difficult to achieve ideal aesthetic results and need maintenance. Bartlett and Varma⁷ in 2017 reported that composites used in the treatment of tooth wear require continuing repair and constant review, increasing the long-term costs. The restorative challenge is,

what to do if composites continually fail, if the tooth wear is too extensive for composites or if patients ask for crowns.

Crowns on the other hand are destructive and can lead to further complications such as loss of vitality. In young patients, the long-term maintenance of restorative treatment must be considered. Walton *et al.*⁸ among others⁹ suggested that crowns could last up to 15 years, however, this and most other studies tend to be based on single tooth crowns that are not prescribed for patients with extensive tooth wear. There has been a report comparing crowns and composites in toothwear cases¹⁰ showing better survival estimates for anterior crowns; but the patient numbers were low. The European consensus report⁵ noted that patient's wishes are a factor in decision making. Therefore, the operative treatment of tooth wear must include consideration for crowns.

Planning crowns for patients with tooth wear

Stabilisation of active disease is a key starting point and a detailed diet history is often used to ascertain potential causes. If there is suspicion of gastro-oesophageal reflux then this should be managed with the appropriate medical colleague. A periodontal assessment should confirm excellent oral hygiene which is necessary for maintenance of multiple crowns particularly if crown lengthening will be required.

¹Prosthodontics, King's Dental Institute, Guy's Hospital, London, UK

*Correspondence to: Sachin Varma
Email: sachin.varma@kcl.ac.uk

Refereed Paper. Accepted 3 January 2018
DOI: 10.1038/sj.bdj.2018.170



Fig. 1 Failed composite restorations prompting discussions for future restorative options



Fig. 2 Diagnostic wax-up based on ideal proportions of tooth height and width as well as patient feedback



Fig. 3 Intraoral mock-up derived from diagnostic set-up mimicking the effects of crown lengthening

After extensive tooth wear there is usually a limited amount of tooth structure and vertical space is needed for restorations. Space can be created by increasing the occlusal vertical dimension (OVD) and when the wear is localised, direct composite restorations, utilising the Dahl concept is a possible treatment outcome.¹¹ Anterior restorations placed at an increased OVD cause posterior disclusion and over 3-6 months the anterior teeth intrude and the posterior teeth

overerupt, re-establishing an even occlusion. In cases of localised tooth wear the Dahl concept is a predictable method to reverse the effects of dento-alveolar compensation. In cases of generalised wear, a conventional full arch rehabilitation can be prescribed at an increased OVD. This has the advantage of not waiting 3-6 months for Dahl movements to occur but is more invasive and costly. Splitting the treatment into anterior and posterior segments allows easier control over

the occlusal scheme. Treating the full arch in one phase is more technically challenging. If treating in segments, some clinicians advocate tackling the posterior dentition first to control occlusal form for the molars and premolars and to control guidance, especially if attempting to achieve group function. An alternate option is to start treatment on the anterior dentition therefore controlling canine guidance and the aesthetic needs of the patient

A common dilemma is whether lower incisors should be restored. The width of lower incisors are about 30% narrower than the opposing arch and about 40% of lower incisors have two canals¹² with the lingual canal close to where the margin should ideally finish. Tooth preparation increases the risk of pulp damage and the amount of tooth structure left after preparation can be minimal so that even if a crown can be fabricated there is risk of decoronation. Ideally, alternative treatment options should be considered and trial preparations of study casts are useful for planning and to communicate these challenges to the patient. Using composite to build up the lower incisors is more conservative but these often chip or shear off. In a study by Al-Khatt¹³ they reported that over a seven-year period 51% of anterior composites were considered successful, and from this advocated that they are a predictable process. Even the study by Milosevic,⁶ which has the best success rates reported in the literature for composites, show that the lower incisor site is the most challenging area.

Unfortunately, this means there are no simple, reliable options to restore lower incisors and there is no right or wrong method. A discussion with the patient to explain the limitations and failure potentially leading to tooth loss should be undertaken before restorative care. Should crowns fail in the lower anterior region then the next viable solutions would involve implants, dentures or long span bridges from canine to canine, provided the occlusion is favourable and the canines have favourable crown height with sufficient root length.

Whether planning for crowns or direct composite restorations a diagnostic set up is helpful to show the restorations to the patient. They can be converted into an intraoral mock up to allow the patient to see how the crowns would look *in situ* (Figs 2 and 3). It is common to present the patient with a few options and various wax ups to demonstrate the different results.

Surgical crown lengthening

There are situations where the tooth wear is so severe that composites are not going to be successful. Crown lengthening increases the length of available tooth tissue and should be carefully planned in common with all operative procedures. The dilemma is whether this should be considered as a first line treatment or whether composites should be used in the first instance and then to consider surgery if they fail. However, with very short clinical crowns the likelihood that composites will withstand occlusal loads is debatable and so surgery might be a first line option. For patients, they must be made aware of the cost of composites and then the cost of surgery and crowns incorporating maintenance. In these situations, any might choose crowns. Using direct composite build-ups as an initial provisional restoration allows greater flexibility as it gives the opportunity to make adjustments to occlusion and aesthetics before preparation for crowns is carried out.⁴⁻⁶ However, it adds a time consuming stage and more cost to treatment, if crowns are planned some clinicians may choose to skip this stage and proceed directly to provisional crowns.

The patient's oral hygiene must be excellent for crown lengthening to be successful and it is important to assess the crown to root ratio. Crown lengthening usually involves the removal of two to three millimetres of alveolar bone and so careful planning is required to avoid an

unfavourable crown to root ratio which could cause mobility. If the teeth have an unfavourable crown to root ratio before crown lengthening then alternative options should be considered.

A new diagnostic work-up should be produced from the initial record where the crown lengthening surgery is mimicked on the diagnostic casts (Fig. 2). It is possible to transfer this set up intraorally to give the patient an idea of how the crowns might look following crown lengthening. Ideally, the planned post-operative ideal position of the gingival margins should be marked on the casts and then transferred intraorally using a putty matrix and a temporary crown material (Fig. 3). This allows the patient to have seen diagnostic setups with crown lengthening and without to allow them to make an informed decision. It is important to consider the gingival level in relation to the patient's smile lines when planning crown lengthening. The symmetry and the position of the gingival zenith should be planned for aesthetic purposes. The position of the gingiva in relationship to the smile line will determine whether crown lengthening is performed solely in the anterior segment or whether it should extend posteriorly.

After crown lengthening temporary or provisional crowns should be fitted within a few weeks. Leaving a period of around six weeks gives time for the soft tissues to settle whereas leaving a period of 3-6 months is sufficient for full tissue maturation. There is conflicting evidence to support the timing of

when crowns should be fitted. Preparing the teeth within a few weeks helps to establish the new position of the gingival margins. Pontoriero and Carnevale reported coronal tissue rebound on patients with a thick tissue biotype.¹⁴ Delaying the procedure may provide more control against gingival bleeding, but increases the risk of re-bound.

The design of the crown preparation depends on the material to be used. This should be discussed with the patient, giving guidance for options that best suit aesthetics and longevity. The occlusal scheme should be copied from the diagnostic wax-up to provide temporisation which can be at an increased vertical dimension utilising Dahl movements or as part of a full arch rehabilitation.

Provisionalisation

The term 'provisional' is an interim phase of treatment and allows the clinician and the patient to test-out the restoration from both a functional and aesthetic perspective. It allows the patient time to adapt to the new occlusion and provides an opportunity to make changes and to assess the long term prognosis of dubious teeth. The provisional restorations are designed using the diagnostic wax-up and should be made of a material that is easily adjustable chair-side. The goal is to try out the restorations clinically and to easily adjust the occlusion and aesthetics so that the provisional restorations will finish in an ideal shape and form that can be copied in the definitive restorations.

For tooth wear this phase is essential as in most patients some degree of bruxism or attrition is active. This means that if provisional crowns are linked there is no potential to assess the crown shape and occlusion for individual teeth. Using individual provisional crowns allows the operator to test the preparation length, crown height and the occlusion before the definitive restorations.

Traditional materials for provisional crowns used to be heat-cured acrylic crowns which are packed and flaked in much the same way as a denture. Heat-cured acrylics are durable but short term. These types of crowns could be put in for months to assess function and the overall aesthetics. Acrylic crowns have been superseded by laboratory based composite such as Gradia Lab (GC Corp, Leuven, Belgium) resin composite. These are reinforced laboratory composites with larger filler particles and wear rates that are superior to clinical composite. As with acrylic, these crowns could be in place for



Fig. 4 Gold palatal backings 11, 21, 22, 23



Fig. 5 Crown preparations for upper incisors and canines, metal ceramic crowns, provisional crowns on premolars Gradia (GC Corp)



Fig. 6 Metal ceramic crowns fitted



Fig. 7 Monolythic lithium disilicate crowns (25 to 15) remaining dentition monitored with old restorations *in situ*

months to test the aesthetics and the occlusal scheme. Furthermore, they are more readily added to with composite. Modern techniques for provisional crowns include the use of polymethyl methacrylate (PMMA) which can be milled as part of the CAD-CAM flow. There is limited long-term clinical evidence for the use of PMMA, however, one cannot ignore this technology.

Definitive crowns

The choice of material for full coverage crowns can vary from case to case. In reality, material choice tends to be the prerogative of the clinician and influenced by the skills of the technician. Gold backings are a minimally invasive technique to treat tooth wear but metal ceramic crowns provide strength and

reasonable aesthetics; all ceramic crowns give far superior aesthetics but have been in clinical use for less time.

Gold palatal backings are a traditional method, adopted mainly in the UK, to treat tooth wear at an increased vertical dimension. The technique for gold palatal veneers is to take conventional impressions of the worn dentition and to cement them onto the palatal surfaces of the upper anterior teeth. Gold, preparation-less, overlays can also be placed on the posterior dentition (Fig. 4) Chana *et al.* reported the use of adhesive technology as minimally invasive and claimed they had advantages over conventional preparations.¹⁵ The main disadvantage is that these restorations have poor aesthetics and in the present dentistry climate, the demands for a more aesthetic solution may be sought by some patients. Therefore, this solution may be unsuitable for the majority of the population; in a practice setting this technique is of limited use.

Metal ceramic crowns are a traditional restoration in the treatment of tooth wear. The typical method of construction is a cast coping followed by firing of feldspathic porcelain onto the casting. These have a good evidence base compared to other types of crowns and have been in clinical use for decades. There have been various studies to support their use.^{8,9,16} However, care must be taken in looking at these studies as none of the mentioned papers look exclusively at the treatment of tooth wear.

The dimensions for a metal ceramic crown are traditionally a 1.5 mm reduction for a shoulder preparation on the facial aspect of the tooth followed by a chamfer finish on the palatal aspect of 0.5 mm. The porcelain is fused to the metal in the firing process through contraction and van der Waal's forces. The nature of the material provides strength and reasonable aesthetics provided enough space is given to layer porcelain (Figs 5 and 6). However, there is often a compromise between sufficient tooth reduction needed for aesthetics and endangering the long-term prognosis of the tooth. Sectional matrices derived from the diagnostic set up give a good indication of how much tooth structure to remove. Metal palatal surfaces should be used to reduce the amount of tooth reduction required for the restorations and to avoid the increased wear caused by unpolished porcelain against the enamel of the opposing dentition.

Since the development of aluminous crowns by John McLean, modern all-ceramic crowns have superior strength compared to traditional porcelain jacket crowns. Aluminous crowns have evolved to yttria-stabilised zirconium ceramics which have shown to have high compressive strength. There are numerous variations of zirconia which in general are more opaque with higher strength and more translucent at the lower strength of the spectrum. Their advantage over metal ceramic crowns is that a good aesthetic outcome could be achieved with less tooth preparation.

Compared to yttria-stabilised zirconium, lithium disilicate crowns give excellent aesthetics with lower compressive and tensile strengths (Fig. 7). These materials can be useful in the treatment of tooth wear. Unlike metal ceramic crowns, they need curved line angles on the preparations and adhesive cements can be used to maximise their strength. The translucency of the lithium disilicate can allow excellent aesthetics, but care must be taken to consider the shade of the underlying core shining through. These newer ceramic materials are becoming more popular in practice. This is most likely due to good aesthetic outcomes, reducing laboratory costs and increased laboratory costs of traditional metal ceramic restorations. There is clearly a need for high strength ceramics, but limited long-term evidence to support their use in tooth wear.¹⁷

CAD CAM technology

CAD CAM technology is increasingly available as part of routine prosthodontics and has advantages in the treatment of tooth wear. Digital scanning can be used either intraorally or in the laboratory to capture data either directly or from study casts. Similarly, the restorations can be planned either directly on the design software, or commonly from scans of the diagnostic wax-up. The advantage is that fabrication of the restorations is easier once a digital model has been created, although accuracy for full arch restorations remains challenging.

Facial scans can also be carried out and a virtual articulator is possible. The digital pathway allows the potential for a reduction in time and cost, particularly if multiple restorations are required at the provisional stage as new prototypes can be manufactured at the press of a button. The process of copying the provisional aesthetics to the definitive crowns can be more successful by digital scanning rather than using putty indices. Over the coming years, development of these techniques will change prosthodontics and the management of tooth wear.

Maintenance

On-going maintenance is important to ensure a good long-term prognosis. Excellent oral hygiene is required postoperatively and the interdental spaces of restorations should be designed to be easily cleansable. The condition of the periodontal tissues around the crowns should be monitored along with causes of the original tooth wear such as reflux or acidogenic diet. A Michigan type splint should be worn at night to protect the restorations particularly if parafunction is part of the aetiology of toothwear.¹⁸

The challenge with tooth wear is that the outcome is not predictable. If bruxism contributes to the progression of tooth wear the survival of any restoration is questionable. While composites remain an option for restoration of the worn dentition, some patients prefer a more reliable and long-term outcome and, as a result, crowns remain a viable option. This is probably best illustrated with the dilemma of managing worn lower incisors.

Summary

The use of full coverage crowns remains an important treatment option for the management of tooth wear. Crowns have been considered as replacements for repeatedly failed composites. With new evidence to suggest that the chipping of composites is a reality⁷ and with some patients requesting crowns as part of their management,⁴ one must be able to consider the use of crowns as an alternative

option. Management of tooth wear is challenging as there is limited tooth structure remaining and crowns further compromise the worn teeth. However, if planned thoroughly and executed well, crowns can achieve a favourable and long-lasting result providing the patient with confidence in an aesthetic and functional rehabilitation.

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