Periodontal considerations for adhesive ceramic dental restorations: key points to avoid gingival problems

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Abstract

The stability and health of the periodontal tissues should be a common goal for all dental care providers with regard to natural or restored teeth as well as implant-supported restorations or any other type of prosthesis. The objective of this study was to address the key aspects to be respected when executing adhesive oral rehabilitations involving ceramic restorations, regardless of their thickness, and to reinforce the importance of each step to ensure the success and longevity of the treatment from a periodontal standpoint. This article reviews the fundamentals of the periodontics that relate directly or indirectly to adhesive ceramic dental restorations, and also addresses their clinical relevance.

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Introduction

A healthy periodontium should be the ultimate goal for all professionals involved with comprehensive oral rehabilitations because the health and stability of the periodontal-restorative transition is key to treatment success. Unfortunately, frequent adhesive rehabilitation failures occur because this clear goal for prosthetic rehabilitations is not sufficiently respected. These failures occur as recurrent gingivitis, localized or generalized, or as irreversible periodontal attachment loss through gingival recession and/or periodontal pocket formation that, in extreme cases, may ultimately lead to tooth loss. The recurrence of these clinical scenarios may indicate that there has not been enough commitment to periodontal health by some dental professionals. It therefore seems pertinent to reinforce the importance of the commitment to health, function, and esthetics, in that order. These goals are fundamental to obtain the desired longevity and stability for any provided treatment.

The term ‘contact lenses’ has been increasingly used worldwide by the dental community as a marketing term to describe thin porcelain veneers that aim to improve smile esthetics without dental preparation (no-prep veneers). However, clinical reality has shown that only very few and highly specific situations make it possible to avoid the need for dental preparation while providing the space required for the restorative material. In most clinical situations, the need for a ceramic restoration is highly subjective, and the request for such a treatment by a patient may be comparable with the desire to acquire a fashion/trendy item. When a patient demands a treatment that conflicts with the clinician’s recommendation, the clinician should educate the patient and explain the indications and contraindications of such a treatment so that a fully informed decision can be taken. Despite this ideal approach, unfortunately some clinicians seem more interested in performing the treatment regardless of its clinical indications, which leads to an increase in overtreatments. As a consequence, the rate of retreatments of recently performed adhesive esthetic rehabilitations due to periodontal compromises is also on the rise. With that, the patient enters, often at an early age, the so called ‘restorative cycle,’ which sooner or later culminates in tooth loss.

Most failures occur from what can only be seen as a lack of knowledge of the interaction between restorative dentistry and...
periodontics, sometimes combined with a poor or careless technical execution (Figs 1 and 2). An important factor that seems to potentiate these negative outcomes is the presence of a thin/festooned periodontal biotype, described to present an increased risk of gingival margin instability and consequent esthetic compromise.\(^5\) Patients with delicate biotypes are more prone to developing gingival margin recession as a result of a temporary or prolonged periodontal aggression, often seen in adhesive rehabilitations with ‘contact lenses.’ Therefore, it is important to recall patients presenting delicate biotypes that require extra care when managing soft tissues for restorative purposes (ie, it can be stated that periodontal tissues require clinical respect).

Periodontal clinical respect means to:

1. Preserve the biological space, avoiding the direct contact of the restorative materials with the junctional epithelium (JE) and/or the connective tissue (CT) attachment.\(^6,7\)

2. Optimize the emergence profile and the cervical contour of the restoration by avoiding overlapping or misadaptations that may promote plaque accumulation and/or affect the ideal food trajectory.\(^8\)

3. Avoid excessive manipulation of the gingival margin with retraction cords, hemostatic agents, clamps, impression materials, and inadequate instrumentation.\(^9\)

4. Strive for excellent marginal adaptation, with or without tooth preparation.

5. Avoid the contact of impregnated materials during cementation (retraction cords and an excess of adhesive cement).

6. Ensure adequate sealing and adaptation of the restoration in relation to the dental substrate, avoiding misadaptations, voids, and/or spaces susceptible to subsequent plaque accumulation.\(^10\)

The objective of this article is to address the key factors or ‘rules’ to be respected during the execution of adhesive ceramic restorations, regardless of their thickness, and to reinforce the importance of each step to ensure the success and longevity of the treatment from a periodontal standpoint.
Rule 1: The biological equilibrium of prosthetic/periodontal transition determines the success and longevity of the treatment

For the majority of mammals, teeth are articulated organs. This imposes an anatomical challenge to the organism’s defense system: one third of the tooth is exposed in the oral cavity, in contact with the saliva and diverse microorganisms, and the remaining two thirds are inserted within the bony structure of the alveolar process. Therefore, an efficient and reliable biological seal is essential to maintain a biological and ecological balance between the external and internal environments so as to prevent microorganisms from penetrating the systemic bloodstream. This seal exists through the combined functions of the JE (epithelial seal) and the CT insertion (connective seal), which in combination form the so-called biological space

The first line of periodontal defense consists of the oral epithelium (OE), particularly the inserted gingiva. This epithelial layer is stratified and keratinized as well as impermeable and resistant to mechanical, chemical, and bacterial aggressors. It is considered to be part of the protective periodontium as it plays a role in protecting the more internal organic layer – the CT – from coming into contact with external agents. Like other epithelial tissues, the periodontal epithelium exhibits little interstitial space, with its constituting cells very close to each other and with few to no blood vessels. Therefore, the nutrition of this outer layer is provided by the underlying CT through the basal layer of the epithelium. Often, with the goal of increasing the area of nutrition, the epithelium can project crests toward the inner CT that can increase in number and size in the presence of inflammatory processes.

Due to the dual environment (external and internal) in which a tooth exists, the OE invaginates toward the tooth surface to form a sulcus. This sulcular epithelium (SE) is less keratinized and has characteristics similar to those of the OE, with a superficial layer of keratin. This characteristic allows it to seal the internal and external environments and therefore represents the primary line of periodontal protection. On average, it is 0.7 mm long in the vestibular surface and 1.0 mm long in the interproximal surface of the anterior teeth (Fig 3). It is clinically important to recall that the SE can only be evaluated histologically (eg, it is not possible to perform a probing evaluation).
However, it can be assumed that, as this is a transition tissue, it will present much variability among different individuals and should be considered the anatomical and histological limit for the intracrevicular level of a restorative margin preparation.

A second epithelial layer – the JE – lies underneath the SE and presents distinct histological characteristics compared with the OE and the gingival epithelium. The JE is not keratinized and is therefore permeable, allowing for fluid exchange between the internal and external environments. The JE only presents two layers of cells – the external lamina (EL) and the internal basal lamina (IBL) – with only the former providing tissue stability and sealing by adhering weakly to the surface of the enamel through hemidesmosomes. It is through the JE that the humoral and cellular defenses come into contact with external agents, as in cases of tissue inflammation. Additionally, the JE is responsible for the secretion of the gingival crevicular fluid.

In cases of lesioning (common during periodontal probing and/or procedures such as prophylaxis and the insertion of a retraction cord for impression, amongst others), the JE is able to regenerate quickly (in 48 h) unlike the other epithelial tissues.

The following are some critical clinical aspects regarding the JE:

1. Being a permeable tissue, no restorative material or debris resulting from clinical procedures should remain in contact with the JE due to the risk of inducing transient or permanent gingival inflammation.

2. The conventional periodontal probing performed with a Williams or North Carolina millimeter probe should be performed with a slight digital pressure, since the depth of the clinical sulcus differs from that of the gingival sulcus that often encompasses a small or medium portion of the JE. Thus, this clinical measurement should not be used to define how far the probe can penetrate into the gingival sulcus under pressure, since this action will likely invade the JE.

3. The restorative materials currently available for restorative adhesive dentistry are biotolerable but not biocompatible. This means that they should not remain in contact with the JE because an antigen-antibody reaction may occur. Ideally, these materials should be bioactive, stimulating cellular proliferation and adhesion, which is similar to what happens in oral and orthopedic implantology with materials such as titanium and zirconia as well as polymers such as polyetheretherketone (PEEK). Even implant-supported restorations, being transmucosal in nature, have been considered by some authors to invade the biological space.

From the approximate level of the cemento-enamel junction (CEJ), the JE gives way apically to a CT insertion. The CT forms a union through connective fibers with the root cementum. This connection is real, since the tooth end of these fibers is mineralized and anchors in the cement surface (the Sharpey’s fibers). From this mineralized origin they direct toward the CT of the gingival margin, being part of its structure. From a sealing perspective, an important function of the CT is to prevent apical migration of the JE, keeping the level of the gingival margin in position.

Rule 2: The excellence of the clinical execution is more determinant than the selected restorative material

Several factors should be observed to achieve periodontal health in the vicinity of a dental restoration, regardless of its extent and the material used. The primary factor relates to the vertical location of the tooth.
preparation limit. In this respect, two elements should be considered: first, ensuring an appropriate distance for an adequate restorative emergence profile; and second, aiming whenever possible for a supragingival (SupG) or equigingival (EqG) restorative limit. However, if a subgingival (SubG) limit is unavoidable, the preparation limit should remain in contact with the SE (an impermeable tissue), penetrating a maximum of 0.5 mm on the vestibular surface and 1.0 mm on the interproximal surfaces in relation to the free gingival margin.21

In addition to the vertical level of the preparation limit (SupG, EqG or SubG), the overall excellence of the tooth preparation and the adequate adaptation of the overlaying restoration (temporary or permanent) is paramount to achieving periodontal health. An inadequate dental preparation may result in excessive restoration contouring, an inadequate emergence profile, an incorrect occlusal design, and ultimately in functional and esthetic failure.

It is important to recall that the purpose of any dental preparation is to provide space for the restorative material. In rare exceptions, a tooth may present a deficient coronal volume and therefore require no preparation (Fig 4a). However, even in the case of a tooth with such characteristics, it is important to plan for the position of the cervical and interproximal restorative limits of the future restoration. It is also important to plan for its emergence profile in such a way that a predictable adaptation in the restoration is achieved, avoiding possible periodontal damage. This cervical and interproximal demarcation should be smooth, with an average depth of 0.2 to 0.4 mm to avoid cervical dentin exposure (Fig 4b).

According to Richter and Ueno,22 the definition and excellence of the preparation limit may be even more important than its vertical level in relation to the free gingival margin. Preferably, dental preparations should not be positioned within the gingival sulcus,21 ideally being 0.2 to 0.5 mm above the gingival margin, especially when the color of the substrate is favorable (Fig 4c).

SupG preparations have various advantages as they are more accessible during the execution of several clinical procedures, including easier access and visualization during preparation, facilitated impression or scanning as well as for oral hygiene procedures and long-term maintenance.21,23

Despite all the previous considerations, SubG preparations are justified in certain situations:
1. Substrate discoloration (Fig 5).
2. Replacement of restorations that already
Subgingival preparations are justified in situations of substrate discoloration that require total coverage of the tooth by the restoration. Figure (e) shows that sometimes it is important to restore the discolored substrate with direct opaque composite resin prior to cementation.
present with SubG preparations or restorations (Fig 6).
3. For SubG caries.
4. For diastemas that require a suitable proximal emergence profile to optimize the position of the interdental papilla (Fig 7).

In the above cases, there is a justifiable need to extend the preparation within the sulcus. However, the position of the JE must be fully respected, and direct contact of the restorative material should be limited to the SE, which is keratinized and impermeable. Since the SE is a tissue with unique characteristics
that are clinically indefinable, parameters such as probing should not be used in the decision-making process regarding how much a particular sulcus can be penetrated in relation to the free gingival margin. It is important to consider that in the vast majority of individuals, the gingival sulcus (or SE) has a perennial distance, being a transitional epithelium between the OE and the JE.11

From an evidenced-based dentistry (EBD) standpoint, some of the previously mentioned clinical considerations regarding the relational dental preparation limit and the periodontal tissues have already gained consensus with the scientific community, these being:

1. The JE is part of the biological space and is permeable. Therefore, any restorative material that contacts its surface will have an almost direct contact with the underlying CT and will generate varying levels of inflammation.24

2. The restorative materials available for dental restorations are only biotolerable, not biocompatible or bioactive.25 All restorative materials (direct or indirect, temporary or final) can generate antigen-antibody reactions and should not come into direct contact with the JE, with the exception of titanium, zirconia, and PEEK.6,19

3. The vast majority of patients present with thin/festooned periodontal biotypes, which increases the risk of periodontal harm, gingival margin stability, and a resultant esthetic compromise.5 Depending on the periodontal biotype, different clinical and histological responses may arise from a biological space violation: periodontal pocket formation, gingival recession, and/or apical migration of the dentogingival complex.26

In summary, it is important to define clinical strategies, not only regarding the preservation of hard dental tissues but also in terms of respecting the periodontal involvement. These clinical strategies should translate into sufficient invasiveness, adequate instrumentation, EBD clinical protocols, and the employment of premium materials. Well-adjusted provisional and/or final restorations directly affect the final restorative outcome as well as the health of the adjacent tissues. An in-depth knowledge of the histoanatomy of the periodontal tissues and an awareness of how certain prosthetic procedures can impact periodontal health are prerequisites for any clinician involved in adhesive restorative dentistry.
Rule 3: The periodontal biotype is fundamental to define the vestibular convexity of the restoration

The periodontal biotype is a factor of paramount importance for the esthetic risk assessment in restorative dentistry and its observance is fundamental to selecting the adequate treatment sequence and protocols, including preparation, impression procedures, temporization, and cementation. The periodontal biotype is directly related to the convexity of the vestibular surface of natural teeth, which plays an important role in directing bolus trajectory during mastication and promoting proper stimulation and toning of the gingival margins.27

When the periodontium is thin/festooned, the teeth usually present a more pronounced vestibular convexity, located between the middle and cervical thirds of the crown, which seems to alleviate the direct impact of food on the periodontium. Clinicians should be careful not to cause overcontouring in cases of no-prep as this could lead to periodontal damage. (Fig 8)

The flat and thick periodontium is typically more mechanically resistant and is generally associated with teeth that have a flatter vestibular surface. This biotype is less sensitive to dental procedures and may allow for certain clinical indelicacies without resulting in permanent periodontal damage.28 On the other hand, this biotype appears more prone to developing periodontal pockets in the presence of inflammation, which may mask the evolution of irreversible tissue loss.15

Rule 4: A respectful transition between the periodontium and restoration increases the consistency of the clinical results

The tooth-restoration-periodontium interface should be optimized, with the aim of achieving harmony between tissues that are very different from an anatomical and biological standpoint. The position, preparation limit, emergence profile in combination with the vestibular contour of the ceramic restoration, and establishment of an “area of adhesive continuity” (AAC)29 allow for an adequate perio-restorative integration, facilitating plaque control in the cervical region (Fig 9). The AAC, forming a hybrid interface of different structures that have been bonded together, results from the correct adap-
tation between them, so that there are no discrepancies that promote plaque accumulation.

Not only the clinician but also the dental technician/ceramist must be knowledgeable about the biological implications of the indirect restoration being produced in order to ensure an adequate finishing and adaptation of the restoration margin as well as an appropriate emergence profile. The dental technician must observe the position of the soft tissues and respect the biological space in no-prep cases, participating together with the clinician in the material selection process for each particular situation.

Finally, care during the bonding of ceramic dental restorations is fundamental to attaining a successful perio-restorative interface connection. Attention should be paid to the choice of the composite resin cement viscosity and the adhesive protocol, which must be respected and followed meticulously. The use of gingival retraction cords should be restricted to cases where complete hemostasis is not attainable in the JE, allowing for the passage of crevicular fluid from the internal to the external environment. In these cases, a thinner retraction cord (No. 000), impregnated with an aluminum-based hemostatic solution (to avoid subsequent spotting) should be selected and positioned at the level of the JE (ie, it should not be apparent). Retraction cords should also be used in cases of SubG preparations, since mechanical separation is required. The shorter the time the retraction cord is kept in position, the better for the health of the periodontium. On the other hand, there is no need to use gingival retraction cords in the case of a SupG preparation with healthy periodontal tissues.

While absolute isolation (with rubber dam) is fundamental to control humidity, it may be deleterious to the gingival margin during cementation. Alternatively, this control could be achieved with relative iso-

Fig 9  (a to c) The position, preparation limit, and emergence profile in combination with the vestibular contour of the ceramic restoration as well as the establishment of an area of adhesive continuity (AAC) allow for an adequate perio-restorative integration, facilitating plaque control in the cervical region.
lation through the use of saliva absorbents and lip retractors or by utilizing modified absolute isolation.

Another important aspect is the sealing of the restoration and the flow of the cement. During this procedure, the clinician should be careful to prevent the formation of voids that occur when air is trapped between the restoration and the tooth surface. Once the restoration is fully seated, the excessive cement should be carefully removed using appropriate instrumentation, brushes, and floss, ideally under magnification. Light curing only the central area of the restoration through the use of collimating tips on the photopolymerization device facilitates the complete removal of the resin cement. This helps to ensure that there is no excess material before the final polymerization of the resin cement at the AAC.

In cases of multiple restorations, the gingival retraction cords (if indicated) should be removed only after complete photopolymerization of all the elements. After this has been completed, marginal finishing should take place, for which No. 12 and/or No. 12D scalpel blades, prophylactic strips, dental floss, and in some cases rubber cups with fine polishing pastes may be used.

A follow-up appointment should be scheduled to assure that the periodontium in the vicinity of the new restoration presents a healthy appearance, with no signs of inflammation, pain, heat, redness, tumor, and/or exudate.

**Final considerations**

Many factors can be related to the periodontal success of an adhesive dental rehabilitation. Although techniques and materials will change and evolve over the years and new tools will emerge, the biology will not change. The clinician and dental technician/ceramist are obliged to keep abreast of the latest developments and constantly expand their knowledge of the biological behavior of the periodontal and dental tissues in relation to the techniques and materials used for oral rehabilitation, so that by respecting these tissues the success and longevity of the restoration may be fully achieved. The stability and health of the periodontal tissues should be a common goal for all dental care providers with regard to natural or restored teeth as well as implant-supported restorations or any other type of prosthesis.
References