Biological integration of aesthetic restorations: factors influencing appearance and long-term success

Stefano Gracis, Mauro Fradeani, Renato Celletti & Guido Bracchetti

In the past few years, different authors have made efforts to improve both techniques and materials to meet the ever-increasing aesthetic requirements of our patients. However, too often, the emphasis is placed on these factors as the only keys to success. It is instead the integration of a natural-looking prosthesis within a healthy periodontium that should represent the ultimate goal of every component of the dental team: general practitioner, periodontist, hygienist, dental technician and prosthodontist. This chapter summarizes the current knowledge of prosthetic materials and clinical procedures that play a role in any clinician’s attempt to create biologically acceptable and aesthetically pleasing long-lasting restorations.

Restorative margin location and implications for soft tissue stability

Preservation of sound tooth structure and tooth vitality is of the utmost importance in tooth preparation. Trauma to the pulp has to be minimized through the use of an air and water spray. At the same time, there must be sufficient space: cervically to create the correct contour that facilitates plaque removal, occlusally to allow the restoration of a proper occlusion, and axially to provide a proper thickness of veneering material to achieve an aesthetically acceptable result (Fig. 1) (44). Improper preparations may lead to over-contouring of the restoration, poor occlusal design, and poor aesthetics (Fig. 2).

Fig. 1. Tooth preparation should allow enough space cervically, occlusally and axially to give the technician the ability to create a mechanically sound and aesthetically acceptable prosthesis. A shoulder preparation with no sharp angles is excellent for metal-ceramic crowns with butt porcelain margins.

However, for a restoration to become integrated in the mouth, strength and aesthetic appearance alone
width of 1.07 mm and the junctional epithelium a width of 0.97 mm, a high degree of individual variability was reported. The combined dimensions of these two structures represent the biological width. This structure should always be respected (33). However, many authors have highlighted the inevitability of penetrating the epithelial attachment during the prosthetic procedures without this maneuver causing any irreversible damage. Therefore, nowadays, “true” biological width violation means the placement of a restorative margin in the connective tissue attachment.

In health, the gingival margin and the alveolar crest follow approximately the scallop of the cementoenamel junction except interproximally, where the soft tissue col is concave and thus does not mimic the bone crest, which instead tends to be convex or flat (41). The height of the interproximal papilla depends not only on the bone architecture but also on the relative tooth proximity: the closer the crowns, the more accentuated is the papilla because the soft tissues tend to be supported by the proximal contours of the crowns. The farther apart the teeth (that is, in case of a diastema or a missing tooth), the flatter the papilla will be. When preparing a tooth, the tip of the bur should therefore follow the gingival margin or the anatomic configuration of the cementoenamel junction. It is important for the interproximal preparation, especially of the front teeth, not to become too flat; otherwise, there is a risk of violating the connective tissue attachment and therefore the biological width (62).

Depending on the thickness of the underlying bone and the dimension of keratinized gingiva, different clinical and histological responses can result from a supracrestal biological width violation. Usually, with a thick periodontium (fairly flat

Fig. 3. Typical appearance of thick periodontium

Anatomic considerations

The relationships among the tooth-supporting soft and hard tissues, the junctional epithelium, the connective tissue attachment and the bone crest have been clarified in histological studies by Gargiulo et al. (21). Even though the connective tissue attachment was found to have an average apicocoronal

Fig. 2. An overcontoured restoration is often the result of an underprepared abutment. Notice the inflamed gingiva and the opaque appearance of the ceramometal crowns.

are not sufficient. A critical area is the crown–tooth interface and its relation to the periodontal tissues. Therefore, it is important to understand the necessity for a well-fitting restoration (provisional or definitive) and how both the position of the preparation margin with respect to the gingiva and the procedures necessary to define and record it affect the quality of the final restoration and the health of the surrounding tissues. Knowledge of the anatomy of the periodontal tissues and an awareness of how, under certain conditions, the prosthetic procedures can lead to gingival inflammation, recession, or pockets are prerequisites for any clinician doing this work.
cementoenamel junction and gingival scallops, thick cortical plates and increased thickness of keratinized gingiva), little apical migration of the dentogingival unit and intrabony pocket formation are observed (Fig. 3) (63). In the presence of a thin periodontium (high gingival scallop, thin cortical plates and limited thickness of keratinized gingiva), gingival recession and apical migration of the dentogingival unit may instead be observed (Fig. 4). This migration is sometimes self-limiting, as observed by Tarnow et al. (59).

Prominent roots need to be evaluated to identify any fenestrations or dehiscences. These conditions associated with a thin periodontium contraindicate the placement of a restorative margin intracrevicularly.

Supragingival versus intracrevicular margins

Regardless of the preparation design and its coronoapical position, a precise and well-defined margin should always be achieved. As Richter & Ueno stated (51), marginal fit and finish may be more significant to gingival health than the location of the margin. Ideally, the margin of a prosthetic restoration should be easily accessible for the following reasons:

- to facilitate fabrication of the provisional restoration;
- to facilitate impression taking;

Fig. 5. Supragingival margins are easier to prepare and record in the impression; furthermore, in conjunction with all ceramic restorations, they can allow a very natural-looking result. In this case, the crowns are in Empress.

Fig. 6. A shoulder preparation with an intracrevicular margin. The ceramometal crown has emergence profile that supports the soft tissues.

- to allow assessment of the fit of the restoration;
- to allow margin finishing and burnishing; and
- to facilitate plaque removal.

Supragingival margins stay away from the periodontal tissues, and thus, they are easier to prepare, record in the impression, and maintain (Fig. 5) (7). This is in contrast to the “subgingival” margins, which impinge on the junctional epithelium or even the connective tissue attachment. Intracrevicular margins are defined as those confined within the gingival crevice (Fig. 6) (6, 33). Different studies (42, 60) have demonstrated conclusively that periodontal tissues show more signs of inflammation around crowns with intracrevicular or subgingival margins than those with supragingival margins. There may be a number of reasons for this result (17, 26):

- defective margins;
- inaccurate fit;
- roughness of the tooth–restoration interface;
- improper crown contour;
- violation of the connective tissue attachment; and
- greater pathogenicity of the subgingival dental plaque.

However, even if from a periodontal point of view it is preferable to have exposed (supragingival) margins, in clinical practice, the following factors may force the clinician to place a restoration margin intracrevicularly:

- need to improve the resistance and retention form of a short clinical crown;
- presence of caries or restorations extending apical to the gingival margin;
- modification of the emergence profile; and
- aesthetics.

In these cases, the key factors for achieving a healthy and aesthetically pleasing result are proper margin placement during tooth preparation, gentle tissue management techniques during impression taking, and the fabrication of restorations (both provisional and definitive) with high-quality margins (25, 26, 51, 61).

Initial therapy should always be the first step in the treatment of patients who need a restorative procedure. Intraculcular preparations should be performed exclusively in presence of a healthy crevice: only when it is inflammation free is the gingival margin stable and less prone to recession and can be probed and packed more accurately (63). The healthy crevice is shallow, generally ranging in depth from 0.5 to 1.0 mm on the facial aspect of the anterior teeth (12, 52). Therefore, an intracrevicular margin should be placed 0.2 to 0.5 mm apical to the free gingival margin on the facial side. Interproximally, because the sulcus normally is deeper, the preparation can extend more apically to better support the soft tissues. Be aware, however, that an increase in gingival inflammation has been reported as the restoration margin approaches the base of the sulcus (42, 61).

Some authors (6, 63) suggest placing a retraction cord in the sulcus before finalizing the preparation. This maneuver has two advantages: it highlights the base of the sulcus and therefore the ultimate limit of the preparation before causing irreversible damage, and it pushes the gingival margin outward and apically to better expose the unprepared tooth structure to be removed (Fig. 7). Margin placement has to respect the attachment apparatus and to allow for some degree of error during the high-speed instrumentation (6).
Fig. 7. A thin periodontium is readily displaced vertically by a retraction cord.

The sequence of clinical steps consists of:

- tooth preparation to the gingival margin;
- placement of an extra-thin knitted retraction cord that displaces the gingiva outward and apically; and
- definitive margin preparation to the top of the cord achieving a new, more apical position.

Role of provisional restorations

Fabrication of a provisional restoration is an extremely important phase of treatment. Provisional restorations are needed to protect the prepared teeth, to reduce the sensitivity of the vital abutments, and to prevent tooth migration. They are also instrumental in developing the correct aesthetics, phonetics and occlusal scheme before fabrication of the definitive restoration (65). More importantly, well-contoured and well-fitting provisional restorations allow the periodontal tissues to stay or become healthy. Special attention should be dedicated to the development of the proper emergence profile of the provisional prosthesis both interproximally and buc-

colingually to allow the patient access to all areas to maintain periodontal health (Fig. 8). This preparation depends on the patient's periodontium type. Some authors have stressed the importance of avoiding overcontouring of highly scalloped thin tissue; otherwise, recession may occur (62).

Much time and effort should also be dedicated to assuring an optimal fit of the resin provisional, avoiding open margins and overextension or underextension. When relining provisional with the direct method, a multiple reline technique should be used (6). Alternatively, margins can be checked and finalized on a stone die poured from an impression of the prepared tooth.

Special care should be directed to minimizing mechanical and chemical trauma to the natural dentition and to the periodontium during provisional fabrication. In particular, the potential trauma to the pulp of the direct technique caused by the heat of polymerization and the presence of the monomer is significant, especially if the thickness of residual dentin is limited (5). To minimize pulpal temperature rise and gingival irritation, it is

Fig. 8. Provisional prosthesis should be fabricated with the proper contours and emergence profile, both interproximally and buccolingually, to allow the patient access to all areas to maintain periodontal health.
tissue type (thick versus thin) and the position of the preparation margin (at the gingival margin versus intracrevicular), different tissue management procedures are indicated. The objective of tissue retraction is to expose all of the prepared tooth structure and, possibly, a portion of the unprepared root beyond the margin by causing a horizontal and vertical displacement of the marginal gingiva. This can be achieved easily by placing in

Fig. 9. An ultrathin (000) cord is placed around prepared teeth. If sulcus is shallow and cord causes sufficient displacement of gingiva, no additional cord is placed.

strongly recommended that an external air–water spray be used in combination with regular removal from the preparation of the setting provisional restoration (39).

Impression technique

The impression technique can have a negative impact on the soft tissues around the abutments, even causing irreversible damage if the technique is not properly carried out. Depending on the soft

Fig. 10. Use of double cord technique. The first cord is ultrathin (000) cord, which will stay in place throughout impression taking, while the second cord is one size bigger and will be removed just before injection of impression material.
the sulcus one or two knitted cords (Ultrapak; Ultra-
tradent Products, Salt Lake City, UT) of a suitable
size. A single-cord technique is the least traumatic
option and is normally employed when the sulcus
is shallow and the margin is placed only minimally
in the crevice (Fig. 9). The cord is usually impreg-
nated in a buffered aluminum chloride solution
(Hemodent; Premier Dental Products, Norristown,
PA), and it is removed at the time of impression.
The exposure of the tissues to the prolonged pres-
ence of an astringent solution is well documented
in the literature (8, 11, 40, 49). A double-cord tech-
nique is used when the sulcus is deeper (Fig. 10).
From the point of view of prosthetic convenience,
it may be desirable to employ this technique be-
cause it yields more extensive displacement. How-
ever, the soft tissue anatomy on the buccal aspect
of the anterior teeth rarely permits two cords to be
placed. In the presence of a limited facial crevice,
a selective double-string technique is better, the
second cord being placed only interproximally and
lingually. The second cord is usually one size big-
ger than the first, and it is soaked to control fluid
seepage and any slight bleeding. The first cord,
which stays in place throughout the impression
procedure, is left untreated.

Root proximity may create severe problems in ob-
taining good impressions because there will not be
enough space to accommodate the retraction cords
and, subsequently, a proper thickness of impression
material. The placement of cords in such restricted
interproximal spaces may cause irreversible damage.
Possible solutions to this problem are:

- partial- instead of full-coverage restorations to
  avoid preparing and restoring the side of the tooth
  with the proximity problem;
- more apical placement of the restorative margin if
  the root trunk tapers apically or an odontoplasty
  with a flame-shaped bur to increase the separa-
tion;
- orthodontic movement to separate the teeth; and
- strategic extractions.

Choice of restoration and
preparation designs

The selection of the restorative material and the rela-
tive tooth preparation design should be performed
only after the clinician has considered the variables
that play a role in the decision-making process of

Fig. 11. Cementation of two feldspathic porcelain veneers
allows a high degree of light transmission, which makes
the restorative margin virtually invisible.

any treatment plan that contemplates the placement
of one or more prosthetic restorations:

- tissue type;
- coronoapical position of the crown margin rela-
tive to the gingival margin and to the need of
  maintaining the tooth's vitality;
- tooth vitality;
- abutment integrity;
- abutment height;
- occlusal clearance for proper strength;
more and more the traditional approach of full crowns. This is especially true when restoring single vital teeth. In the past few years, clinical evaluations of porcelain veneers have documented positive results in terms of fracture rate, debonding, microleakage, soft tissue response, aesthetics and longevity (13, 20, 30, 46, 47). Enamel-supported restorations have a high light transmission and can be manufactured with several porcelain systems (Fig. 11). For the sake of this discussion, however, only full-coverage restorations will be considered, because they still constitute the bulk of the prosthetic work performed in a typical dental office and because they are the real challenge as far as the integration with the surrounding soft tissues. At the same time, it is interesting to note how, for single teeth, the use of traditional cemented complete-coverage restorations that may extend intracrevicularly is increasingly limited to two situations: 1) restoration of severely damaged teeth and 2) replacement of existing full-coverage crowns (30).

**Appearance and integrity of the abutments**

The color of the abutment and the presence of metallic or dark core materials, especially in endodontically treated teeth where posts are often used, are primary factors affecting the appearance of the prosthesis. This is particularly true in the cases in which full ceramic restorations are planned (Fig. 12).

In order to have a preparation with an adequate retention and resistance form, often, vital teeth and all nonvital abutments need some form of preprosthetic reconstruction. The choice for a core build-up material was traditionally made among amalgam, glass-ionomer materials and composite resins. More recently, the use of amalgam has decreased because of biocompatibility issues, poor initial resistance (need to wait 24 hours to finalize the preparation), and fragility if its thickness is <1 mm, among other reasons. Glass-ionomer materials, even the reinforced ones (such as Ketac-Silver; ESPE, Seefeld, Germany), are usually not recommended because their low tensile strength makes them prone to fracture (24, 28, 36), especially if they are used for large build-ups not sustained by surrounding dentinal walls.

When only a minimal amount of tooth structure has been lost, the authors prefer employing a composite resin, as it allows a conservative approach and the possibility of matching the dentin's color. However, even when adhesive agents and materials are

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**Fig. 12. Color of abutment and presence of metallic or dark core materials are primary factors that can affect color of gingiva and aesthetic appearance of prosthesis. This is particularly true when full ceramic restorations are planned, as was the case with these two Procera crowns.**

- aesthetic needs of the patient; and
- parafunctional habits.

Only a careful evaluation of each of these features can indicate which preparation design is most suitable in each particular case.

**Full crowns versus porcelain veneers**

The successful creation of adhesively luted conservative restorations (porcelain veneers) is challenging...
used, it is a good habit not to rely solely on the chemical adhesive’s strength for long-term retention of the core. Because these restored abutments are subjected to repeated stresses such as tensile stresses when a provisional crown is removed, it is highly recommended that some sort of mechanical retention (undercuts, pins) be incorporated (45).

When a great amount of coronal tooth structure is missing, as is the case with most endodontically treated teeth, one of the main problems that needs to be addressed is the retention of the build-up material. In some cases, an adequate retention is obtained by locking the material in the pulp chamber, but very often, a post cemented in one of the canals is needed (1, 38). There are several post systems available. To choose the “ideal” post material, it is important to consider features such as rigidity (stiffness) and color.

Although the clinical effectiveness of rigid metal posts is well established, some clinical reports have linked a greater likelihood of root fracture to their use (4, 37, 50, 57). For this reason, the use of posts with a modulus of elasticity similar to that of dentin has been recommended (16). In this study the authors consider carbon fiber posts a valid alternative since, according to the research they carried out, the above-mentioned physical property and the ability to be bonded apparently create a homogeneous unit that can reduce stresses to the root and the potential for fracture. On the other hand, some authors (32, 55, 58) have highlighted the consequences of using such a system in conjunction with a rigid ceramic or metal-ceramic crown. One group (55) concluded that “the potential for flexure of the carbon fiber post on loading could result in the loss of the cement lute marginal seal with the accompanying microleakage of oral bacteria and fluids”.

From an aesthetic point of view, a metal post has a significant disadvantage in that its presence does not allow sufficient light transmission through the cervical portion of the root. Thus, it can affect negatively the aesthetic quality of the final restoration. This is particularly true in patients with a thin periodontium and a high smile line. As a result, alternative “aesthetic” post systems have been developed in the last few years (Fig. 13) (18). Table 1 summarizes the indications, advantages, and disadvantages of the different aesthetic post systems available.

It is senseless to use the aesthetic post systems and highly translucent metal-free restorations if the tooth’s substrate is dark as a result of prior endodontic treatments. In these cases, internal bleaching has been suggested before proceeding with the reconstruction of the abutment (Fig. 14). However, there are reports of external root resorption and decreased bond strength to resin cements following such procedures when chemicals for chairside bleaching
Table 1. Aesthetic post and core systems

<table>
<thead>
<tr>
<th>Metal-ceramic post and core</th>
<th>Metal or carbon fiber post with composite core</th>
<th>Zirconium post with composite core, Cosmopost, In-Ceram post and core</th>
<th>Quartz and fiberglass post with a composite core</th>
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<tr>
<td>Indications</td>
<td>To be used in presence of a thick periodontium and low lip line, as grayness caused by metallic post inside root has an impact on the final result.</td>
<td>To be used in presence of a thick periodontium and low lip line, as grayness caused by these posts inside the root has an impact on the final result.</td>
<td>Can be used in presence of a thin periodontium and high lip line and in teeth with no discoloration or that have been bleached. When the post space has an adequate diameter.</td>
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<tr>
<td>Advantages</td>
<td>Direct technique: only one appointment is required for the fabrication of the restoration. Carbon fiber post can bond to tooth structure.</td>
<td>Natural root color.</td>
<td>Natural root color. Direct technique: only one appointment is required for the fabrication of the post and core.</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>The stiffness of the post may cause root fracture. Carbon post can allow too much deformation of the abutment and therefore can result in marginal leakage of the cemented crown.</td>
<td>No long-term data are available on the clinical performance of this material. Stiffness of the post can cause root fracture.</td>
<td>No long-term data are available on the clinical performance of this material. These posts can allow too much deformation of the core and therefore can result in marginal leakage of the cemented crown.</td>
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were applied (2, 10). Therefore, it is suggested that a walking bleaching procedure be performed and that at least 2 weeks then elapse before luting a post. Recurrence of the dark pigments is to be expected in most cases.

Preparation designs

Preparation designs for full-coverage restorations may be classified into four distinct types (Fig. 15):

- feather-edge;
- chamfer;
- shoulder with bevel; and
- shoulder.

A brief description of the salient features and indications of each type of design follows.

Feather-edge (vertical preparation)

Frequently used for gold cast crowns and porcelain or resin-veneered crowns in periodontally involved cases, the feather-edge preparation design requires the least amount of tooth structure removal. The finish line is often hard to read, however, and finishing and polishing can be difficult (64). It yields limited resistance to marginal distortion during porcelain firings and it can result in overcontouring of the final restoration if porcelain is applied close to the margin. For these reasons, its application is confined to those situations where removal of a limited quantity of tooth structure is of paramount importance for the long-term preservation of the abutment’s integrity and where the patient accepts the presence of a metal collar (44).

Chamfer (“hybrid” preparation)

Widely used for cast restorations or for ceramometal crowns with a minimal metal collar, the finish line

Fig. 15. Diagrammatic representation of four types of preparation design. A. Feather-edge. B. Chamfer. C. Shoulder with bevel. D. Shoulder.
of a chamfer preparation is easy for the clinician to prepare and for the technician to read. However, according to some authors (15, 54), the thin metal collar may distort during the firing of porcelain, thus producing inaccurate margins. A thermal cycle at oxidation temperature immediately after casting apparently decreases the likelihood of such distortion, but there is no agreement among different authors on this issue (9, 23). The visibility of the metal does not allow these crowns to be used in areas where the aesthetic demands are high (Fig. 16).

**Shoulder with bevel (vertical preparation)**

The shoulder with bevel can be used for ceramometal crowns, full gold crowns and gold crowns with resin facings. This design was originally advocated by Rosner (53), who demonstrated how the bevel can improve fit. Subsequently, this concept was demonstrated to be effective only above 70° shoulder-to-bevel angles, therefore losing most of its clinical utility (35). It is more conservative than a full shoulder preparation, but the presence of the metal collar necessitates an intracrevicular preparation in aesthetic areas (Fig. 17).

**Shoulder (horizontal preparation)**

The shoulder is probably the most popular design because it is very easily read by the technician, and it allows sufficient bulk for porcelain to produce aesthetically pleasing restorations. It can be used for all-ceramic or metal-ceramic crowns with either a metal collar or a porcelain butt margin. The preparation should display internal rounded axial angles (14) to decrease stress concentration and reduce the risk of porcelain failure. However, castings made for a flat shoulder preparation may display a relatively poor fit, whereas excellent accuracy can be obtained with porcelain margins (48).

**Metal-ceramic restorations**

Because of their strength, durability and relative simplicity of fabrication, metal-ceramic restorations are the most widely used for both single crowns and fixed partial dentures (6). However, these advantages were often counterbalanced by a less-than-ideal aesthetic result when the appearance of both the crown (especially of the cervical one third) and of the surrounding soft tissues were analyzed. In recent years, the effort to improve the aesthetic potential of metal-ceramic restorations has brought about a number of technical improvements and new metal framework designs. The most important development is without a doubt represented by collarless metal frameworks (Fig. 16).

The aesthetic appearance of the traditional apically extended frameworks often leaves much to be desired because of the lack of brightness and liveliness in the marginal soft tissues surrounding the prosthesis. As a consequence, they take on a bluish hue. This is true both in the presence of a vital abutment and in case of an endodontically treated tooth.
sociated use of fluorescent porcelain margins are effective in obtaining a certain degree of brightness in the root and allowing the illumination of the periodontal tissues typical of natural dentition. At the same time, collarless metal-ceramic restorations have demonstrated the same resistance to axial pressures as metal-ceramic restorations with a traditional framework (3, 27, 43).

If the tooth to be restored has no discoloration and no previous restoration that extends intracrevicularly, the choice of an all-ceramic crown allows the operator to maintain the prosthetic margin supragingivally or at the gingival margin. Thus, it is possible to avoid the time-consuming complications associated with an intracrevicular extension while still achieving a very aesthetic result.

All-ceramic restorations

The increasing aesthetic awareness of patients has led to the search for metal-free restorations and to the development of new ceramic systems that challenge traditional metal-ceramic restorations (34). The improved physical characteristics of these materials and the introduction of a new generation of dental adhesives and resin cements have in fact resulted in predictable and consistent clinical performance, especially when they are used for single anterior restorations (19, 31, 56). The likely explanation is that the all-ceramic restoration and the residual tooth structure are mutually reinforced by the adhesive cement (29). On the other hand, multistep cementing procedures are demanding and technique sensitive, cement removal is difficult, and a dental technician with adequate experience is needed. Short-span fixed partial dentures may also be fabricated with some of these ceramic systems. However, the standard for fixed partial dentures from restored with a post and core (Fig. 17). Magne et al. (30) extended this notion, introducing the concept of the “umbrella effect”; that is, the absence of indirect light penetration into the soft tissues because of the shadow cast by the upper lip on the cervical part of a restoration with a metal substructure.

To solve these problems, Geller (22) suggested a reduction of the metal to provide space between the gingival margin and the most apical border of the framework, allowing room for the application of shoulder porcelain and the passage of light. An adequate reduction of the metal framework and the as-

<table>
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<th>Table 2. Reduction requirements for full crowns and porcelain veneers</th>
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<tr>
<td><strong>Full crowns</strong></td>
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<tr>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Metal-ceramic</strong></td>
</tr>
<tr>
<td>Facial</td>
</tr>
<tr>
<td>Lingual (if in metal)</td>
</tr>
<tr>
<td>Oclusal or incisal</td>
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Fig. 17. Hemiseected molar is a typical situation where a metal-ceramic crown with a metal collar is indicated.
a structural and biomechanical point of view is still metal-ceramic restorations.

An all-ceramic restoration can be selected on the basis of specific criteria, such as mechanical properties and light transmission. In this context, it is useful to classify the materials used for single-unit restorations in two main groups: alumina-based ceramics and non-alumina-based (glass) ceramics. The first group encompasses Spinell (Vita Zahnfabrik, Bad Sackingen, Germany), In-Ceram (Vita Zahnfabrik), and Procera (NobelBiocare, Göteborg, Sweden). In the second group can be included Dicor (Dentsply) and Empress and Empress 2 (Ivoclar-Vivadent, Schaan, Liechtenstein). The materials in the former group typically display higher strength and limited translucency (alumina is relatively opaque) (Fig. 12, 18), whereas those in the latter group show a higher translucency but more limited strength (Fig. 5). As a matter of fact, so far, only two systems are apparently indicated for use as single posterior crowns: In-Ceram and Procera. All new ceramic systems share a common goal: to limit the occurrence of complete failures caused by fractures that encompass both the core and the veneering material. This goal has been achieved by developing cores strong enough that the fractures are limited to the veneering material, thus approaching the failure pattern typical of metal-ceramic restorations.

The reduction requirements for the two types of crowns, metal-ceramic and all-ceramic, are listed in Table 2.

**Conclusions**

Recent progress in restorative materials and clinical techniques, especially those in the field of adhesive dentistry, can indeed make it easier for a general practitioner or a prosthodontist to create natural-looking restorations. However, no matter how significant new material developments may be, by themselves, they will never provide the key to success in prosthodontics. Tissue management is of utmost importance and the real basis on which to determine whether a prosthesis has been properly fabricated and has been integrated in the mouth of a patient. Bringing the periodontal tissues to a state of health and maintaining such a state throughout the therapy and beyond requires careful planning and execution during all phases of the restorative treatment (Fig. 19). This can be achieved only through extreme attention to detail and the allowance of an appropriate amount of time to carry out every single procedure, as it is necessary to do when relining provisional restorations, making impressions and removing excess cement around the restorations.

This chapter reviewed some of the most significant concepts and clinical considerations relating to restorative procedures in light of recent and older literature. The aim is to focus the attention of the clinicians on the aspects that should always be kept in mind when trying to replace missing tooth structure.

**Acknowledgments**

We thank Silvano Sandrini and Giancarlo Barducci, Master Dental Technicians, for their invaluable efforts in always providing restorations that enhance the clinical work while adding an artistic flare to something that otherwise would be a mere tooth substitute at best.
Fig. 19. A. Typical appearance of the gingiva right after the preparation of the teeth and the insertion of new provisional crowns. B. Healing of the gingival tissues 4 weeks later. C. Aspect of the tissues the day of impression taking. D, E. Close-up view of the definitive Empress crowns 4 weeks after cementation. F, G. Aspect of the gingiva around the same crowns 7 years later: the margin has remained stable and no gingival recession has occurred.
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