Ceramic Laminate Veneers: Continuous Evolution of Indications

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Initially used to treat tooth discoloration of various kinds, porcelain laminate veneers have been increasingly replaced by more conservative therapeutic modalities, such as chemical bleaching and microabrasion.[1,2] However, this evolution has not led to a decrease of indications for ceramic laminate veneers, because numerous new ones recently have been developed.

INDICATIONS FOR PORCELAIN LAMINATE VENEERS

Currently, there are three principal indications for ceramic laminate veneers: tooth discoloration resistant to vital bleaching procedures, the need for major morphologic modification in anterior teeth, and rehabilitation of compromised anterior teeth.

Type I: Tooth Discoloration Resistant to Vital Bleaching Procedures

Teeth heavily discolored due to tetracycline therapy (degrees III and IV[3]) and anterior teeth that present severely worn-down incisal edges that subsequently lead to an infiltration of the exposed dentin represent, without any doubt, the most traditional indications for ceramic laminate veneers.[3] These situations, which often require only minimal tooth preparation, are definitely the most difficult to manage from the perspective of color. In fact, the dental ceramist has to ensure an effective masking of the underlying discoloration and, simultaneously, create the illusion of a natural-appearing optical depth of the tooth. In certain cases the inclusion of distinct and characteristic features, such as intense colorations, spots, and imitations of fissures, may facilitate the final integration of the veneers, in spite of the lack of thickness of the restorative material (Figure 1).

Type II: Anterior Teeth Requiring Major Morphologic Modifications

Patients with particularly developed demands for esthetics and conditions that would be difficult to correct by means of direct adhesive composite restorations comprise type II indications for ceramic laminate veneers. In the child such conditions preferably would be treated by the application of direct composites as interim restorations prior to the final laminate veneers, which would be fabricated later, in adulthood. There are three subcategories:

Type IIA: Conoid Teeth. Conoid teeth naturally represent an ideal configuration for the use of laminate veneers and the preparatory work only consists in the creation of a clearly visible marginal delimitation, allowing the establishment of a precise and well-defined margin of the ceramic workpiece (Figure 2).

Type IIB: Closure of Diastemas. In the adult it is not recommended to close diastemas through direct application of composite, because this toilsome procedure does not permit adequate and simultaneous control of shade, form, emergence profile, and cervical adaptation. Ceramic laminate veneers, however, can satisfy these parameters, if a specific tooth preparation is performed.

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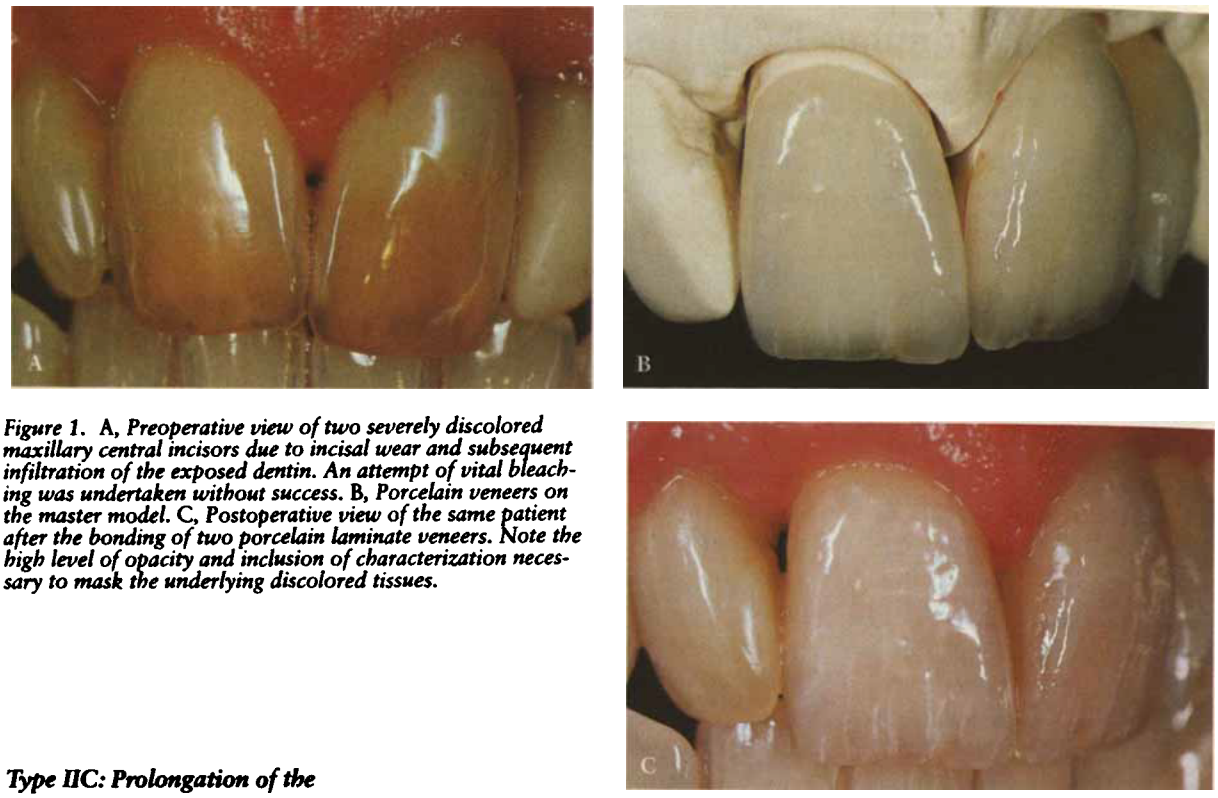

Figure 1. A, *Preoperative view of two severely discolored maxillary central incisors due to incisal wear and subsequent infiltration of the exposed dentin. An attempt of vital bleaching was undertaken without success.* B, *Porcelain veneers on the master model.* C, *Postoperative view of the same patient after the bonding of two porcelain laminate veneers. Note the high level of opacity and inclusion of characterization necessary to mask the underlying discolored tissues.*

Type IIC: Prolongation of the Incisal Edge. Direct composite restorations often present signs of early fatigue (chipping-type fractures) in cases where the entire incisal edge has been restored. In cases where the entire smile of the patient is considered, the general form and length of the teeth involved combine with this lack of durability to present a challenge to the achievement of an esthetic result. Porcelain laminate veneers offer a more predictable result, although they require moderate sacrifice of sound tooth structure and may cost more (Figure 3).

Type III: Extended Rehabilitations of Compromised Anterior Dentition In the presence of coronal fractures or congenital or acquired malformations, the tooth damage sometimes involves the major part of the coronal volume or of the tooth surface.

Type IIIA: Extended Coronal Fractures. The primary advantage of porcelain laminate veneers in cases of extended coronal fractures is that the vitality of the teeth is maintained, even in cases with considerable pre-existing tooth damage (Figure 4).

Type IIIB: Congenital and Acquired Malformations. Generalized dysplasia of the enamel, which requires a more global approach, may be treated successfully and rather conservatively by means of bonded ceramic restorations, if the junction between enamel and the underlying dentin has not been altered. However, in the presence of an amelogenesis imperfecta particular prudence is mandatory and most frequently a full coverage prosthetic procedure remains the treatment of choice.

DIAGNOSTIC APPROACH

A systematic and rational diagnostic approach should enable the patient to visualize and subsequently to approve the planned treatment objective. In all cases, study casts are prepared first, with the redefinition of the desired tooth morphology (wax-up) and eventually of the surrounding soft tissues. Esthetically relevant parameters, such as axis of facial symmetry, tooth axis, course of the gingiva, interdental contact area, general arrangement and form of teeth, and course of the incisal edges, as well as the patient's smile line have to be considered during this process (Figure 5, A–C).[4–8] In a second phase, an in vivo evaluation of the diagnostic effort is performed, whereby two clinical situations can be distinguished: augmentation and reduction of tooth volume.

The need to redefine tooth volume in the sense of an augmentation occurs most frequently. In this situation it is possible to fabricate a diagnostic acrylic template directly in the patient's mouth, using self-curing acrylic resin in a silicon matrix (Figure 5, D). The patient can easily assess this simple removable mask (Figure 5, E and F).

Modifications of the initial diagnostic study can be carried out and integrated into the template. The actual tooth preparations are performed only after the patient's approval of the diagnostic template (Figure 5, G and H).[9] This simple and effective approach can be summarized as follows:

1. Diagnostic wax-up on the study casts
2. In-mouth fabrication of an acrylic template using a silicon matrix.

Figure 2. A, *Frontal view of a young patient, displaying an insufficient temporary crown on a maxillary central incisor and two conoid lateral incisors.* B, *During preparation a silicon guide, derived from the diagnostic wax-up, is used. Only pellicular preparation of the lateral incisors was required for laminate veneers.* C, *Final aspect after cementation of a porcelain-fused-to-metal crown on the central incisor and two bonded porcelain laminate veneers on the lateral incisors.*

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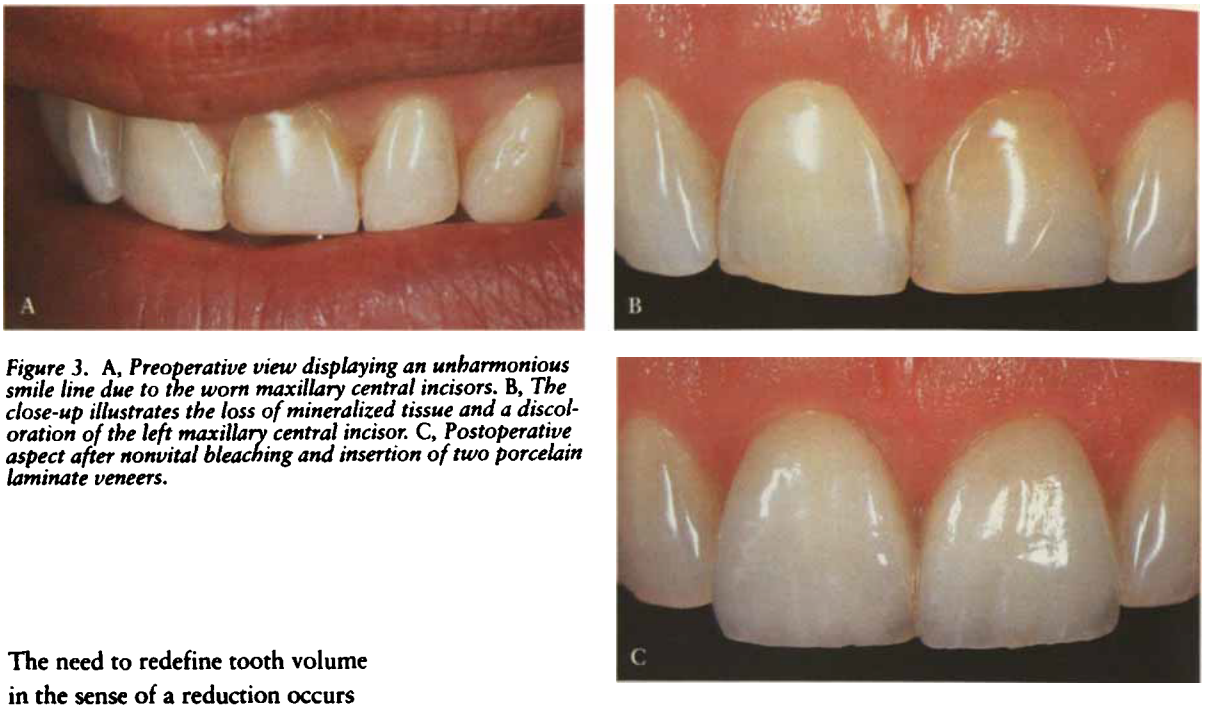

Figure 3. A, *Preoperative view displaying an unharmonious smile line due to the worn maxillary central incisors.* B, *The close-up illustrates the loss of mineralized tissue and a discoloration of the left maxillary central incisor.* C, *Postoperative aspect after nonvital bleaching and insertion of two porcelain laminate veneers.*

The need to redefine tooth volume in the sense of a reduction occurs rarely and does not allow the option of a diagnostic in-mouth evaluation of the envisioned therapeutic objective prior to the preparation of the teeth. Therefore, the provisional laminate veneers, fabricated as previously described for the diagnostic template, serve as templates. Only in complex preoperative situations would it be justified to fabricate transient laminate veneers in the dental laboratory after a precision impression has been taken. If the preparations prove adequate, the same impression would subsequently be used for the production of the master model. This second approach summarizes as follows:

1. Diagnostic wax-up on the study casts
2. Tooth preparations guided by the use of a silicon matrix derived from the diagnostic wax-up
3. In-mouth fabrication of acrylic veneers (diagnostic template)
4. Final impression
5. Fabrication of the definitive porcelain laminate veneers.

More complex situations would require steps 1 and 2 as above, and

3. Final impression
4. Laboratory-made provisionals
5. Final restorations.

TOOTH PREPARATIONS

Even extended losses of mineralized tissue (large Class IV defects) can be restored by means of laminate veneer. A preprosthetic composite core buildup does not contribute to an increase of mechanical resistance.[10] Nevertheless it appears that, to date, no scientific report has specifically addressed the potential biomechanical problems that might be associated with these different clinical approaches. A preexisting incisal edge restoration of good quality, eventually anchored by a parapulpal pin or screw, can

be used as a supplementary preprosthetic restoration. In fact, existing Class III restorations must be carefully examined for their quality and replaced only when indicated. To avoid useless sacrifice of mineralized tissue, the interproximal preparation limits for a laminate veneer may be located within the bulk of an interdental composite restoration.

General Recommendations

In the case of bonded ceramic restorations, the physicochemical characteristics and the adhesive properties of the luting composites allow substantial stresses at the tooth–restoration interface. Because the geometric and mechanical parameters of the tooth preparation are of secondary importance, there is maximal preservation of sound mineralized tissue during the actual preparation procedure. Nevertheless, a minimum amount of preparation geometry is still required to facilitate insertion and positioning of the ceramic workpiece during the final bonding procedure.

Special Recommendations

Control of Tissue Reduction. The principle of long-lasting tooth–prosthesis conexus implies the achievement of a sufficient and homogeneous ceramic thickness, providing the restoration with a maximum intrinsic mechanical resistance. Silicon matrices sectioned in different planes constitute a simple and efficient method to guide each preparation step. It is important that these preparation guides reproduce the diagnostic wax-up as accurately as possible. For that particular purpose it is recommended that the silicon material be submitted to a pressure of 4 atmospheres during its actual polymerization on the study cast (Figure 6).

Figure 4. A, *Status after coronal fracture of left and right maxillary central incisors.* B, *The preparation for laminate veneers maintained the vitality of the central incisors.* C, *Final view after the placement of two bonded porcelain laminate veneers.*

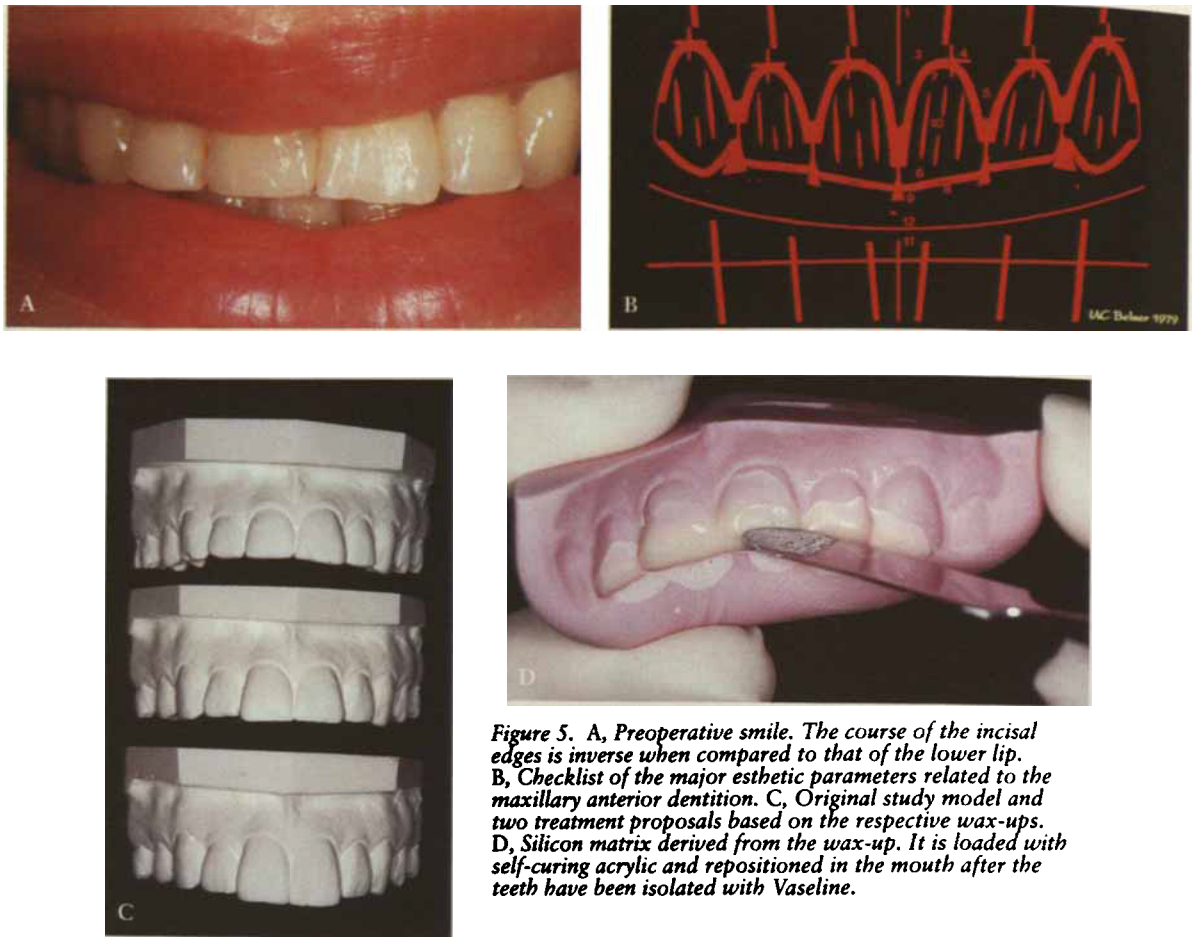

Figure 5. A, *Preoperative smile. The course of the incisal edges is inverse when compared to that of the lower lip.* B, *Checklist of the major esthetic parameters related to the maxillary anterior dentition.* C, *Original study model and two treatment proposals based on the respective wax-ups.* D, *Silicon matrix derived from the wax-up. It is loaded with self-curing acrylic and repositioned in the mouth after the teeth have been isolated with Vaseline.*

Configuration and Localization of Margins. The preparation limits should allow simultaneously an optimum marginal adaptation of the final restoration and an utmost respect of the hard tissue morphology. The preparation should be only superficial, which means not more than 0.5 mm within the enamel thickness. However, the exposure of dentin often occurs in the cervical and interproximal regions.[11] Consequently, the creation of a cervical and interproximal chamfer, without internal line angles, and respecting the scalloped gingival contour is recommended. The insertion of a deflexion cord facilitates this task by underlining the individual gingival perimeter. The preparation instrument is kept at a constant distance to the cord of approximately 0.5 mm, creating a paragingival margin. At present no scientific evidence exists with respect to the type of incisal finish line to be recommended as a function of the type and amount of incisal overlap. One can question if the palatal "mini-chamfer," which is habitually performed,[12] should not occasionally be replaced by a more simple finish line in the sense of a "butt margin." This possibility should be investigated in view of the stresses provoked by the antagonistic

incisors during protrusive movements of the mandible. Furthermore, the localization and the type of tooth to be restored by means of a laminate veneer (maxillary incisor or mandibular incisor) should also be taken into consideration, because specific morphologic and functional aspects are related to these parameters. In this context, cases to be treated due to coronal fractures have to be examined in particular. In fact, given that the surface to be bonded is reduced, it may be necessary to create an extended chamfer on the palatal aspect, to significantly increase the surface for adhesion.

Wrapping. Both the interdental and the incisal localization of the margins strongly depend on the initial preoperative situation and the restorative objective. In case of minimal preparations, interproximal contacts may be maintained. However, if major changes in form or the closure of diastemas are planned, a maximum wrapping-around is recommended. Basically, the interproximal margins are extended in a palatal direction (beyond the interproximal contact points), and on the incisal aspect, a distinct overlap in the form of a hollow chamfer is performed. The

Figure 5. E, *The acrylic, which has been molded on the teeth prior to preparation, is retrieved and can be used as a removable diagnostic template.* F, *The patient can try-in and assess the new configuration, which represents the planned future restoration in form and length of the teeth involved.* G, *Close-up view of the upper four incisors restored with porcelain laminate veneers.* H, *The patient's postoperative smile documents the harmonious integration of the four laminate veneers.*

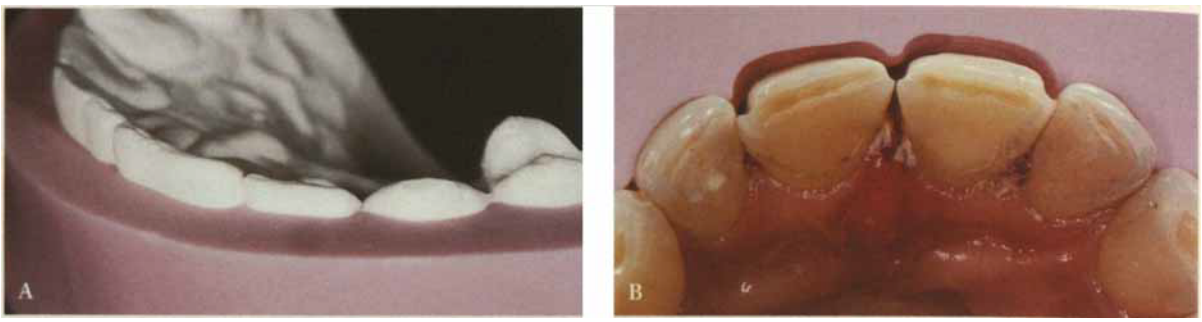

Figure 6. A, *A silicon key, precisely adapted to the diagnostic model, will be used for intraoral preparation control.* B, *Occlusal view of the maxillary central incisors prepared for laminate veneers.*

described extensions of the preparation enhance the liberty of the dental ceramist with respect to form and emergence profile of the future restoration, as well as in regard to an improved esthetic definition of the porcelain in the crucial incisal zone. Generally, the establishment of an interproximal and incisal overlap comprises various other advantages, facilitating numerous treatment phases and, most of all, the placement of the final restorations (stabilization of the laminate veneers and easy access to all the margins during the bonding procedure). The systematic creation of an incisal overlap, although applied in practice by the majority of clinicians, has been only little explored scientifically in relation to the biomechanical integration of veneers. The same is true for interdental wrapping, which tends to give a design to the laminate veneer that is close to that of a three-quarter crown.[13] In a photoelastic study, the authors underline the importance of incisal and interdental overlap, which appear to lend to the ceramic a superior intrinsic resistance, due to a better stress distribution in the restoration itself.[14] This observation merits to be verified by more sophisticated means of investigation. In any case, in the course of an extensive interdental preparation, one should avoid creating too marked an extension toward the palate. In fact, in a normal situation, the palatal overlap should generally remain clearly inferior to the incisal height of the porcelain restoration itself. The interdental wrapping, however, tends to favorably modify this relation to the benefit of the palatal zone. Due to the natural elasticity of the underlying mineralized tooth structure, a region of stress concentration is formed between the incisal edge of the laminate veneer and its palatal extension. Therefore, a palatal butt margin is recommended in the case of extensive interdental preparation. Two approaches appear feasible in the presence of Class III restorations that extend in a palatal direction: (1) complete wrapping of the restorations in association with a flat overlap (butt margin) or (2) partial interdental wrapping with a palatal mini-chamfer. Again, one should avoid a total wrapping in combination with a long palatal chamfer.

Softening of Contours. The prepared surface should not present any sharp angles. Particular attention should be addressed to two strategic zones: at the marginal level in the transition zone between the interproximal and the palatal surfaces and at the level of the transition zone toward the axial vestibular surface. Sharp crests are detrimental to the precision of the restoration, as the ceramic, due to the pyroplastic deformation, only permits high-fidelity reproduction

of surfaces that are gently rounded. Generally, angled areas should be avoided, because they create zones of stress concentrations to the restoration.

Tooth Preparations for Closure of Diastemas. Cases of diastema closure require extended interproximal preparation, allowing the ceramist to create a progressive emergence of the interdental zone of extension. These situations demand careful study of the axis of insertion of the future laminate veneer. Therefore, diagnostic preparation on the study casts is recommended. Particularly in cases with a reduced periodontium, this enables the dentist to determine if a horizontal axis of insertion is required, to preserve the main bulk of the coronal substance in spite of the reduced cervical circumference of the tooth (Figure 7). However, it should be underlined again that, with respect to long-lasting integrity, the choice of a horizontal path of insertion, which is associated with a palatal butt margin (see Figure 7, B), appears to represent a more favorable configuration than an excessive wrapping (Figure 8).

Restoration of Anterior Teeth Displaying a Coronal Fracture. In cases of extended coronal fractures or when there is an indication for an augmentation of the crown length, the laminate veneer will have to reconstitute a significant part of the incisal edge. The few scientific data related to this subject address the incisal height of such a reconstruction, evaluated in vitro by means of a fracture test performed on artificial teeth.[15] Within the limits of this study, restorations augmenting the incisal length up to 2 mm do not appear to present any differences with respect to mechanical resistance, when compared to restorations without overlap. At present, no information is available related to the problem of the geometric ratio existing between the remaining tissues (remaining clinical crown length) and the incisal reconstruction (height of incisal edge), nor related to the recommended type of palatal finish line.

Restoration of Pulpless Teeth. Porcelain laminate veneers are generally not recommended for pulpless teeth. There is, however, no scientific basis for this. It has been clearly demonstrated that both the biomechanical properties and the moisture content of a nonvital tooth can hardly be differentiated from those of a vital tooth.[16,17]

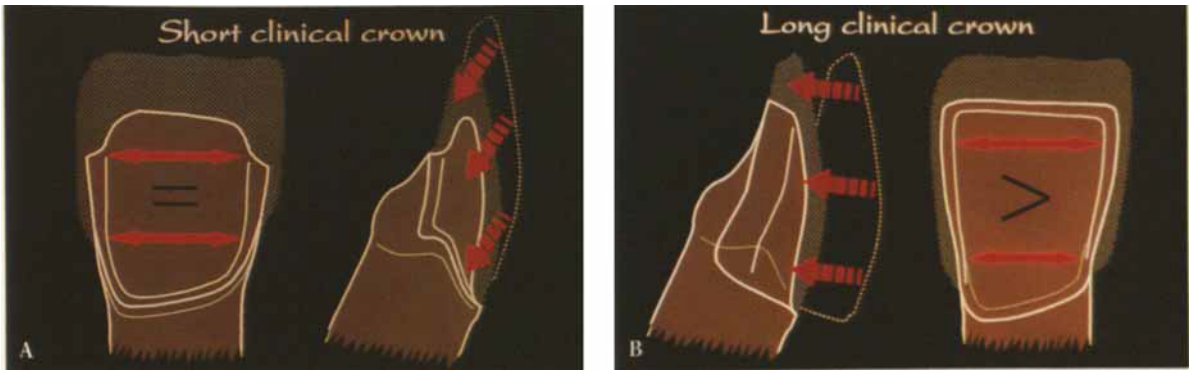

Figure 7. A, *If a tooth presents a normal or reduced length of the clinical crown, the incisal portion of the crown is equal in width to the cervical part. A wrapping-type preparation with an oblique path of insertion can be performed without excessive sacrifice of tissue.* B, *If the clinical crown is long, the incisal portion is distinctly larger than the cervical part. A horizontal path of insertion, associated with a palatal butt margin, is indicated.*

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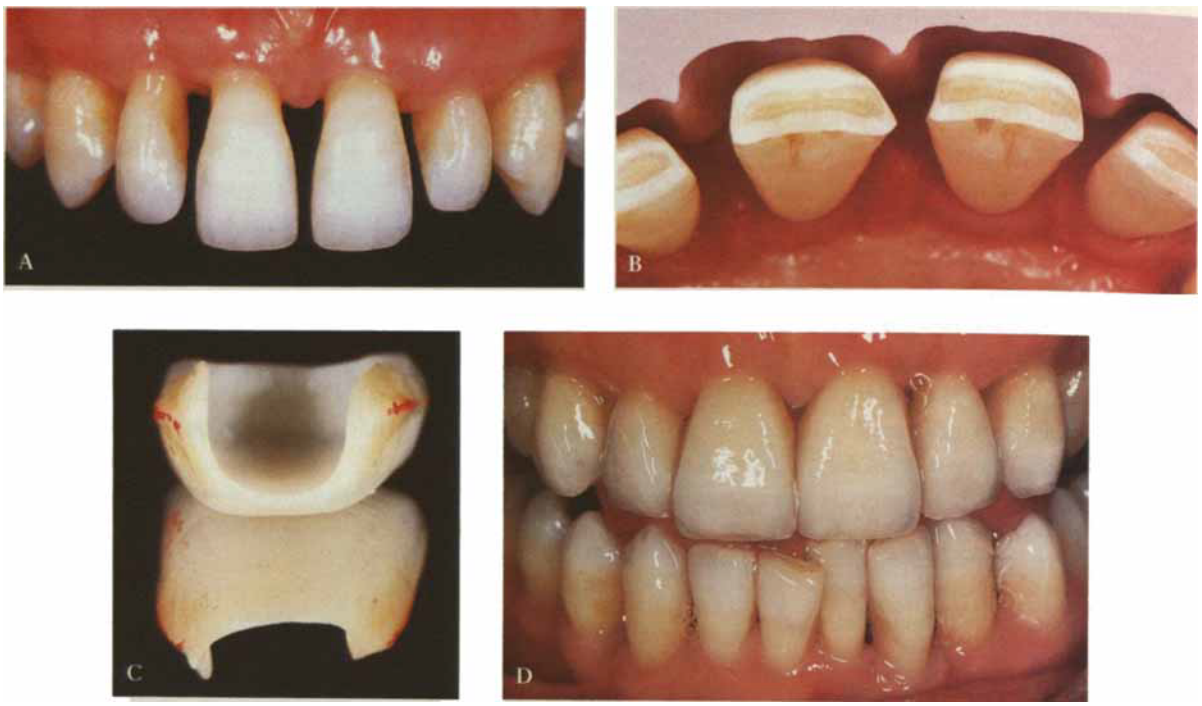

Figure 8. A, *Preoperative view of an anterior maxillary dentition showing multiple diastemas and a vertical loss of soft tissue. The treatment objective comprises the closure of the interdental spaces and a shortening of the incisors.* B, *A horizontal path of insertion with a palatal butt margin has been chosen.* C, *Cervical view of a porcelain laminate veneer, characterized by a marked interdental extension of contour, which creates a vertical line of proximal contact.* D, *The morphology of the veneers contributes to an improvement of both the dental and the gingival esthetics. Note the more saturated and more opaque porcelain in the interdental zones.* E, *The patient's final smile is more attractive due to the disappearance of the interdental spaces and the reduced incisal length.*

Because a bonded porcelain veneer may substantially increase the mechanical coronal resistance,[10,18,19] it appears reasonable to assume that a similar effect can also be found on a pulpless tooth.

Consequently, it should be defined, on the one hand, which restorative means should be selected for the closure of endodontic access cavity (composite resin, glass ionomer cement) and, on the other, if the insertion of an intraradicular post is justified. In this context, the type of the coronal breakdown and the extent of the endodontic access cavity have to be taken into consideration.

Immediate Preparation of Exposed Dentin. If a substantial and accessible area of dentin has been exposed, local application of a dentin adhesive is recommended after the completed tooth preparation, before the final impression is taken. In fact, the dentin adhesive appears to have a superior potential for adhesion when applied to a freshly prepared dentin surface.[20] Furthermore, this precautionary measure protects the pulpodentinal organ and avoids sensitivity during the provisional phase. During the final bonding of the laminate veneer, this surface is carefully cleaned with pumice. The bonding itself is limited to the conditioning of the enamel. On the other hand, dentin adhesion, if performed simultaneously with the final bonding of the ceramic, presents certain problems related to a lack of cohesion within the layer of dentin hybridization.[21] The preceding polymerization of the adhesive appears to be decisive, which leads logically to the application of the dentin adhesive prior to the final impression.

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