Diagnostically Based Protocol for Tooth Preparation

John C. Kois, DMD, MSD; Steve McGowan, CDT

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Dear Reader:

The preparation of anterior adhesive ceramic facial veneers or full-ceramic veneers should not be a dogmatic procedure where all preparations are done exactly the same way. The translucency of this conservative category of restoration offers the advantage of assisting in the final esthetic match by allowing natural tooth color to pass through. At times, however, this translucency can also be problematic, especially when trying to cover discolored teeth, and must be compensated for. In addition, variations in the functional demands of individual patients will require modifying the preparation design. For optimal adhesion, it is always desirable to keep the preparation in enamel, but sometimes this is not possible because of many factors. Analysis of these factors and justification must be carefully considered before preparation. Finally, the restorative material should not require excessive tooth reduction just to satisfy fabrication criteria.

Dr. Kois and Mr. McGowan have successfully researched the subject and written an excellent article on it for this issue of *Esthetic Technique*. They discuss how and why each zone of the tooth is prepared to meet the biological requirements of the tooth. In addition, they show how function, dentofacial parameters, and periodontal concerns will often require modifying the preparation criteria and design. Optimal results are achieved by treating each patient individually and not dogmatically treating everyone the same way. This article clearly describes and defines a philosophical and technical approach that allows for the most esthetic and conservative results when using adhesive ceramic restorations.

Dental Learning Systems would like to thank Brasseler USA for sponsoring this clinical series.

Best regards,

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Director, Esthetic Professionals
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Learning Objectives

After reading this article, the reader should be able to:

- explain how a diagnostically based rationale will enhance the predictability of anterior tooth restorations.
- identify the three distinct zones of anterior tooth preparation.
- discuss the tooth reduction considerations and margin design for each zone.

Although technically demanding and product dependent, porcelain laminate veneers offer a predictable option for creating a successful restorative treatment that also preserves a maximum amount of tooth structure. The risk of failure, however, has been shown to increase when primarily bonding to dentin rather than enamel, when the functional relationships are not managed properly, or when the tooth structure to be restored is very dark.

Concepts of anterior tooth preparation for these restorations continue to evolve, creating confusion among restorative dentists and laboratory technicians.
Unfortunately, this confusion tends to result based more on the needs of new and innovative products, which is commercially biased, rather than on concern about remaining tooth structure.

In contrast, a rationale that is diagnostically based provides the opportunity to create a framework of understanding that will enhance the predictability of these restorations in tandem with the improvements and benefits from new technologies. To create a restoration that exceeds our patients’ expectations with minimal compromise to remaining or existing tooth structure, the parameters of anterior tooth preparation are focused on three distinct zones: incisal, middle, and cervical.

Within each zone, the tooth preparation is generated by simultaneously understanding the biomechanical behavior of the tooth structure, functional requirements, dentofacial parameters, and the periodontal concerns of the patient. Therefore, the ultimate design of the tooth preparation is minimized by the needs dictated by product thickness and maximized to benefit the final restorative result (Figures 1 through 7).

**Porcelain laminate veneers offer a predictable option for creating a successful restorative treatment that also preserves a maximum amount of tooth structure.**

**Incisal Zone**

Representing the initial starting point, restoration of the incisal zone is based primarily on the functional and esthetic requirements of the individual patient. If the incisal edge position is correct in the face and in harmony with the smile, no vertical tooth reduction is necessary. This, unfortunately, does not provide the laboratory technician any flexibility to modify shape, position, or incisal translucency. Vertical reduction is not desirable, however, if the functional risk is high. If functional risk is low, the dentist has more flexibility to develop incisal reduction based on...
esthetic dentofacial veneers (Figures 8 and 9).

**Reduction Considerations**

Ideally, the vertical incisal reduction is 2.0 mm from the desired position, where it does not create a biomechanical compromise to the remaining tooth structure. It also offers minimal functional risk to the porcelain extending beyond the incisal edge, and gives the laboratory technician esthetic options to alter tooth form and build incisal effects in the porcelain. In addition, strict guidelines about not reducing the incisal zone more than 2 mm vertically as discussed in previous articles are not supported by clinical findings. Unsupported vertical incisal porcelain even greater than 4 mm is predictable if the angle of anterior guidance and envelope of function are controlled (Table 1).

The parameters of anterior tooth preparation are focused on three distinct zones: incisal, middle, and cervical.

**Margin Design**

Most practitioners recommend a lingual chamfer margin design, which is acceptable, although it is not ideal. It appears more prudent to develop a butt margin design incisally, with its lingual component in enamel and its facial axial line angle rounded. This allows the technician an opportunity to blend the porcelain so that the outline of the preparation will never be visible facially. In addition, the technician and dentist will then have multiple paths of insertion, for simplicity (Figures 10 through 13).

**Middle Zone**

The key concern for this zone is performing minimal facial reduction that retains tooth structure comparable to the retained enamel to optimize the limitations of composite technology. This will provide a unique blend of stiffness vs flexibility and preserve the biomechanical behavior of the original tooth. Unfortunately, this must be balanced by the need to create sufficient porcelain thick-

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**Table 1—Incisal Zone**

<table>
<thead>
<tr>
<th>Key</th>
<th>Margin Design</th>
<th>Instrumentation</th>
<th>Consider Alteration of Incisal Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop optimal incisal position for esthetics and function</td>
<td>Butt</td>
<td>330 MW(^a)</td>
<td>Use less reduction if: Low-risk dentofacial High-risk function</td>
</tr>
<tr>
<td>Objective: 2.0-mm vertical reduction</td>
<td>Lingual finish line in enamel</td>
<td>KS 0 Medium(^a)</td>
<td>Example 1 Use less reduction if: Low-risk dentofacial High-risk function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KS 7(^a)</td>
<td>Example 2 Use more reduction if: High-risk dentofacial Low-risk function</td>
</tr>
</tbody>
</table>

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\(^a\)Brasseler USA®, Savannah, GA 31419; 800-841-4522

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\(^b\)Brasseler USA®, Savannah, GA 31419; 800-841-4522

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Figure 10—The Brasseler tooth preparation kit system\(^a\) includes all of the burs necessary for tooth preparation and insertion of indirect restorations.

Figure 11—Facial view of tooth preparation technique for adhesively retained porcelain restorations. Step 1, incisal zone. Incisal edge reduction depth cuts with a 330 MW.

Figure 12—Facial view, step 1, incisal zone. Gross reduction using a KS 7\(^a\) bur.
ness, which is required for optimum esthetic development.

**Restoration of the incisal zone is based primarily on the functional and esthetic requirements of the individual patient.**

The mean facial enamel thickness in the middle zone is 0.8 mm to 0.9 mm. Therefore, while facial reduction less than this amount is desirable, maintaining the thickness of porcelain less than this amount will create many challenges for the laboratory technician and eliminate options for any core-supported systems.

**Reduction Requirements**

To maintain enamel facially and recreate the original biomechanical behavior of the tooth, a 0.5-mm to 0.7-mm reduction is ideal. Interproximal finish lines should be terminated in enamel to minimize microleakage, and all sharp corners should be eliminated to minimize stress concentration in the porcelain as well as seating concerns for the restoration. Based on functional relationships, as much lingual enamel as possible should be preserved to minimize opposing wear. Dentofacial parameters contribute to significant concerns based on a preference for using only a clear resin-luting agent to develop imperceptible restorations.

For normal-colored teeth providing 1 or 2 levels of shade change (ie, A3 to A1), reduction requirements of 0.5 mm to 0.7 mm are sufficient. However, for tetracycline-stained or very dark teeth, the maximum reduction of 0.8 mm to 0.9 mm is more prudent.

As usual, and especially in these situations, the individual talents of the laboratory technician are far more important than the specif-

| Key: Maintain enamel Minimal structural compromise |
| Objective: 0.5-mm to 0.6-mm—normal-colored teeth reduction 0.7-mm to 0.9-mm—darker-colored teeth reduction Bevel facial incisal edge Proximal finish lines in enamel |
| Margin Design: | Option 1 Maintain contact point if no proximal restorations  Option 2 Open contact point if previous caries restorations or to change tooth form |
| Instrumentation: | KS 0 depth guide 1/2 Diameter 0.5 mm KS 7—gross reduction KS 0—complete remaining preparation |
| Consider Alteration of Middle Zone Reduction When: | Example Dark-colored tooth High-risk biomechanics High-risk function High-risk dentofacial Use 0.6-mm to 0.7-mm facial reduction |
ic brand of porcelain used. An understanding of layering techniques, fluorescence, and optical properties of the materials used is essential.

In addition, the clinician must decide whether to maintain or eliminate the proximal contact from a dentofacial perspective. This decision may be based solely on the need to alter the tooth form or shape. This allows proper space distribution and the creation of teeth in proper proportion. From a biomechanical perspective, previous proximal restorations will necessitate more significant reduction to allow the finish line location that terminates on enamel lingually (Table 2).

**Margin Design**

The facial incisal aspect of the preparation must be rounded and beveled slightly to create an invisible transition of porcelain to the incisal edge and to eliminate stress concentration and seating concerns. All other aspects maintain a butt type of finish line (Figures 10 and 14 through 17).

**CERVICAL ZONE**

The key concern for the middle zone is performing minimal facial reduction that retains tooth structure comparable to the retained enamel.

### TABLE 3—CERVICAL ZONE

<table>
<thead>
<tr>
<th>Key:</th>
<th>Preserve enamel Esthetics requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective:</td>
<td>0.3-mm reduction requirement for normal-colored tooth 0.6-mm to 0.9-mm reduction for dark- to very dark-colored teeth</td>
</tr>
<tr>
<td>Margin Design: <strong>Option 1</strong></td>
<td>Supragingival margin location • Normal tooth color • Minimal change in tooth form</td>
</tr>
<tr>
<td><strong>Option 2</strong></td>
<td>Intracrevicular location • Dark color • Change shape • Close gingival embrasures</td>
</tr>
<tr>
<td>Instrumentation:</td>
<td>KS 0</td>
</tr>
<tr>
<td>Consider Alteration of Cervical Zone Reduction When: <strong>Example 1</strong></td>
<td>High-risk periodontal High-risk dentofacial Low-risk biomechanics Low-risk function Axial reduction 0.3 to 0.9 mm Intracrevicular margin location May be primarily in dentin</td>
</tr>
<tr>
<td><strong>Example 2</strong></td>
<td>High-risk biomechanics High-risk function Low-risk function Low-risk periodontal 0.3-mm supragingival margin location Will be in enamel</td>
</tr>
</tbody>
</table>
except that the enamel is only 0.3 mm to 0.4 mm thick. In addition, the periodontium complicates the management. The preference to maintain enamel, control color, alter tooth form, minimize flexure, and preserve biologic width combine to provide additional unique challenges to the laboratory technician and clinician.

**Reduction Requirements**

To preserve enamel, ideal reduction should be no more than 0.3 mm to 0.4 mm. This minimizes microleakage resulting from more predictable enamel bonding and minimizes the biomechanical compromises to the remaining tooth structure. This is especially critical with endodontically treated teeth. The larger the access opening and the greater the removal of internal tooth structure, the more critical the concerns for cervical reduction. This is especially a concern for a high-risk functional patient where tooth flexure is potentially greater.

Biomechanically and functionally, the minimal cervical reduction requirements are often at odds with the dentofacial concerns. When the teeth are normal color, a 0.3-mm reduction remains ideal for the porcelain to perfectly blend in, creating the contact lens effect. This is only true, however, with clear luting cement. Unfortunately, when teeth are darker than A3 and the requirements for the patient dictate using A1 or B1 shades, more reduction is necessary. As a general guideline, an additional 0.2 mm of reduction is necessary for each additional shade change.

Obviously, these increased reduction requirements compromise the biomechanics and functional concerns of the teeth. Therefore, the dentist must decide where to develop the most appropriate compromise. The priority in this decision is dictated by the individual tooth and patient concerns, not by the needs of the restorative material (Table 3).

**Margin Design**

From a periodontal perspective, supragingival margins are ideal. Concepts of intracrevicular tooth preparation have been previously discussed and are not any different for these restorations. From a biomechanical perspective, the actual configuration of the finish line exhibits little influence on stress variation in the porcelain. The most significant factor in minimizing marginal failure is ultimately the luting layer (Figures 10, 18, and 19).

Based on functional relationships, as much lingual enamel as possible should be preserved to minimize opposing wear.

**Summary**

This article presented a diagnostically generated protocol for anterior tooth preparation for adhesively retained porcelain restorations. This approach eliminates a standardized design based solely on the requirements of restorative materials. By shifting the focus to three distinct zones of the tooth and four diagnostic categories of periodontal, biomechanical, functional, and dentofacial parameters, the clinician can create an individualized design. Therefore, this design is determined based on the need to minimize risk in the highest risk categories. With this approach, we can achieve the best possible result with minimal risks to the remaining tooth structure and the best chance for longevity (Figures 20 and 21).

**References**


1. The parameters of anterior tooth preparation focus on which zone?
   a. incisal
   b. middle
   c. cervical
   d. all of the above

2. Within each zone, the tooth preparation is generated by understanding the:
   a. chemistry of composite setting.
   b. chemistry of etching.
   c. biomechanical behavior of tooth structure.
   d. requirements of the porcelain.

3. The ultimate design of the tooth preparation is minimized by the needs dictated by product thickness and maximized to benefit:
   a. new bondable porcelain.
   b. shade-sensitive luting composite.
   c. the ultimate restorative result.
   d. reduction of laboratory costs.

4. The incisal zone is the initial starting point and is based primarily on the functional and esthetic requirements of the:
   a. individual patient.
   b. skill of the practitioner.
   c. available shades.
   d. available stains.

5. Unsupported vertical incisal porcelain even greater than 4 mm is predictable if which of the following is controlled?
   a. bonding thickness
   b. angle of anterior guidance
   c. cuspid disclusion in lateral
   d. etching time

6. The mean facial enamel thickness in the middle zone is:
   a. 0.1 mm to 0.2 mm.
   b. 0.5 mm to 0.7 mm.
   c. 0.8 mm to 0.9 mm.
   d. 1.1 mm to 1.4 mm.

7. For tetracycline-stained teeth, the maximum reduction of how many millimeters is more prudent in the middle zone?
   a. 0.3 mm to 0.5 mm
   b. 0.5 mm to 0.7 mm
   c. 0.8 mm to 0.9 mm
   d. 1.1 mm to 1.3 mm

8. To preserve enamel in the cervical zone, the ideal reduction is no more than:
   a. 0.1 mm to 0.2 mm.
   b. 0.3 mm to 0.4 mm.
   c. 0.5 mm to 0.6 mm.
   d. 0.7 mm to 0.8 mm.

9. In general, how many additional millimeters of reduction are necessary for each additional shade change?
   a. 0.1 mm
   b. 0.2 mm
   c. 0.3 mm
   d. 0.4 mm

10. The most significant factor in minimizing marginal failure is the:
    a. luting layer.
    b. porcelain structure.
    c. dentin smear layer.
    d. bonding temperature.
Adjusting and contouring techniques to achieve maximum esthetics and optimum function of porcelain or polymer glass restorations:

- Adjusting and contouring porcelain extraorally: Sintered diamonds are preferred over diamond-coated instruments. Sintered-diamond instruments are solid diamond-particle throughout and cut smoothly but never leave black marks on porcelain.
- For interproximal definition and contouring of splinted units, use the 6942-200 diamond disc. The coarse-grit disc has a thin 0.15-mm profile to quickly cut and contour interproximal surfaces (Figure 1).
- For emergence profile and reflective contours, use inverted-cone sintered diamonds (large: 7928.11.080, medium: 7928.11.029, and small: 7928.11.018). Work the rotating instrument away from the margin and at a very slow speed to protect the margin integrity.
- Occlusal adjustment and secondary anatomy refinement: The sintered-diamond football instrument 7379M.023 in either friction grip or straight handpiece is designed to adjust occlusal surfaces. To define the triangular fossa and replace secondary anatomy in the now-functional area, use small and medium inverted sintered diamonds (Figures 2 and 3).
- Incisal adjustment: The diamond disc 952-140 is available in friction grip, right-angle latch, and straight handpiece for quick precise adjustment of incisal edges of porcelain crowns or veneers. This disc features an autosafe chucking center to stop rotation if the disc becomes engaged in contacts.

Polishing ceramic and polymer glass restorations: The following steps will return to porcelain the wet look of the glazed porcelain before adjustment.

- Polish porcelain with Brasseler USA Dialite polishers; begin with the blue coarse wheel, points, or discs to smooth scratches or further reduce the surface (Figures 4 and 5).
- The pink or medium-grit Dialite further prepares the surface for final high shine. Speed range of 3,000 rpm to 7,000 rpm provides optimal polishing while maintaining long instrument life.
- The gray Dialite (wheel, point, or cup) high shines the porcelain, returning the natural wet look (Figure 6).
- Dialite diamond-impregnated polishers are autoclavable and available in latch shank for intraoral use.
- For final polishing of textured and/or faceted surfaces, the Truluster Polishing Kit is recommended. The use of diamond paste and brushes does not remove surface texture.
- For polishing polymer glass, which is less dense than porcelain, the Ceroshine Kit provides a diamond paste with a specific particle range suitable for polymer glass. Included in the kit are scotch brite wheels, goat-hair brushes, a chamois wheel, and a cotton buff.

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