

show that the bond strength of resin cements to dentin is much lower than bonds to enamel, which is why maintaining an enamel periphery is essential.^{11,25-29}

Factors Affecting Tooth Preparation for Esthetic Restorations

The ideal scenario is to keep the bond completely in enamel. Of utmost importance and when properly prepared, enamel substrates provide the most predictable surface to bond porcelain.^{2,3,30,31} The microretentive adhesion of porcelain to enamel has been well documented for more than 20 years.^{2,32}

Unaffected by lingual preparation design, porcelain veneers adhesively bonded to enamel demonstrate the greatest long-term


success rates, making no-preparation veneers the treatment of choice when indicated.^{2,3,30,31} When dentin is involved, an enamel periphery is preferable for predictability.^{2,32} When less than 50% of enamel periphery and less than 50% enamel remain, discussion with the patient about limitations and predictability of the outcome is necessary.^{2,4}

Despite research and many available materials, clinician experience is the most important tool for determining appropriate treatment plans to address clinical concerns and patients' esthetic demands.^{2,4} To determine preparation requirements, a comprehensive clinical examination that includes function and stress analyses and an esthetic evaluation should be completed for every case.^{2,4,14,16,33} During the planning process, dental



Fig 4.

Fig 4. Illustrations demonstrating Class II veneer preparations requiring a modified design. Facial reduction should be less than 0.5 mm, 80% to 95% of the enamel should remain, and 10% to 20% of the dentin can be exposed. (Brown in illustration is exposed dentin.)



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photographs, centric-relation-mounted study models, and other diagnostic records and factors must be considered before undertaking any procedure.^{2,4,14,33}

When given the option, most patients choose the least amount of tooth structure removal.³⁴ By informing patients of restorative options like porcelain veneers and resin-bonded prosthesis that only require 3% to 30% by weight loss of coronal tooth structure, dentists can provide conservative alternatives to conventional full-coverage crowns, which typically require 63% to 72% loss of structure.³⁴ However, it is the patients' teeth, time, and money; therefore, dentists should enable them to make informed decisions that are best for them based on prognosis, advantages, disadvantages, risks, and longevity.

Minimally invasive dentistry has new technical and educational requirements. Clinicians must stay abreast of material selection, adhesive protocol, and scientific advances. They must also understand that space requirements can greatly affect the final outcome of a finished restoration.^{6,35} The space often required for shade change ranges from 0.2 mm to 0.3 mm per shade.^{6,35} The author uses 0.3 mm plus 0.2 mm times each shade change.

Because 50% or more enamel on the tooth is required, 50% or more of the bonded substrate is on the enamel, and 70% or more of the margin must be enamel. The condition or integrity of the substrate to which veneers will be bonded is also important for success.^{6,9,35} Absolute isolation during cementation procedures is essential for bond maintenance, which ultimately protects the internal restoration surface and is necessary for longevity.^{9,35}



Fig 5. Photograph of a minimally invasive or modified prepless Class II veneer preparation design. **Fig 6.** Close-up of a Class II veneer preparation demonstrating a minimal intervention to modified preparation design in facial reduction of up to 0.5 mm. **Fig 7.** Close-up occlusal view of the Class II veneer preparation with a minimal intervention to modified preparation design. **Fig 8.** Photograph of the Class II veneer preparation demonstrating dentin exposure of 5% to 10%, less than the 20% maximum.



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Typical Veneer Preparation Design

Expected veneer longevity depends on tooth preparation, which should be confined to enamel and involve proximal contact areas and functional considerations, such as occlusion.³⁶ It is also necessary to maintain the cervical enamel margin and incorporate the incisal edge to increase fracture resistance and enable proper placement.³⁶ To increase functional and esthetic properties of restorations, proximal extensions should be created just beyond contact areas.³⁶ The clinical success of porcelain veneers depends upon many factors. Although dental and gingival structures play important roles in optical response and withstanding masticatory forces, dentists must consider and recreate many anatomical components while providing functional integrity.³⁶

The typical veneer preparation model is technique-sensitive and incorporates guidelines for achieving functional and esthetic results. When reducing the labial and proximal surfaces, there must be no less than 0.3 mm to 0.5 mm and uniform whenever possible.^{11,37-42} When going from thick to thin—as in a large Class IV incisal fracture or large Class III composite removal—a smooth transition must be incorporated. Extending the preparation interproximally to the lingual aspect of the papilla, parallel to the crown's original form, is necessary to improve adhesion, conceal the margin, allow an accurate impression, and increase the overall veneer strength.^{11,39,42} The decision to reduce the incisal edge should be based on whether there is a need to increase the crown length and the labiolingual width of the incisal edge.^{11,39,42} Since line angles are involved, rounded corners and edges must be established.

Veneers with an incisal butt-joint or feathered edge usually demonstrate fracture loads similar to those of unprepared teeth.^{11,32} In these cases, the incisal edge may be reduced by up to 2 mm.^{11,41,43} However, the preparation's margins must be chamfered and in enamel.^{11,39,41,42,44} The interproximal and gingival margins of porcelain veneer restorations also must end in enamel at or above the free gingival margin or barely within the gingival sulcus when possible.^{11,39,42}

Techniques exist that allow for consistent tooth surface reduction while minimizing it.⁴⁵⁻⁴⁷

Because traditional veneering approaches can lead to significant dentin exposure, strategies should be taken to limit preparations to the enamel.⁴⁶⁻⁴⁸ Using an additive diagnostic procedure and silicone indexes avoids unnecessary dentin exposure, improves biomechanics and esthetics, and allows more predictable bonding.⁴⁸

Defining Classifications of Veneer Preparations

Referred to as no-, minimal-, or conventional-preparation, veneer classifications—or lack thereof—create a large gray zone of misunderstanding and miscommunication with patients and within the dental profession. Left unanswered, questions regarding finish lines, tooth structure removal, and other aspects can cause confusion in practice.

Flaws and inaccuracies in previously proposed preparation guidelines make those guidelines irrelevant.⁴⁹ To dissolve uncertainty, a classification system is proposed to aid with diagnosis, treatment planning, patient education, consent and understanding, and communication among dental team members, and to provide viable solutions to public requests for elective procedures.

Defined as the way something is categorized, labeled, organized, distinguished, arranged, or sorted, classification adds clarity.⁵⁰ Dentistry has distinguished Class I through Class V classifications in operative dentistry; there are inlays, onlays (3/4 and 7/8), and full-coverage crowns in prosthodontics. Classifications exist for furcations in periodontics, lip lines, bone quality, LeForte's CL-I, -II, and -III in orthodontics, removable prosthesis cantilevers, and bone/crest levels. In 1974, Talim and Gohil classified tooth cracks and fractures in endodontics, and Misch classified implant prostheses for patients; in 2009, McLaren classified ceramics.⁹ Since classification systems have infiltrated so many aspects of life, veneers should be no different.

In the absence of widely advocated porcelain veneer tooth preparation guidelines, Table 1 and Table 2 show the basis for a new veneer classification system proposed by the author. The system is introduced to clarify the aforementioned gray zone between classic conventional veneer preparation and no- or

To dissolve uncertainty, a classification system is proposed to aid with diagnosis, treatment planning, patient education, consent and understanding, and communication among dental team members.



Fig 9.

Fig 9. Illustrations demonstrating Class III veneer preparations requiring some “conservative” reduction. Facial reduction is 0.5 mm to 1 mm, the enamel remaining should be 50% to 80%, and dentin exposure maximizing at 50%.

minimal-preparation veneers. This metric provides an accurate measurement system for quantifying tooth structure removal on a case-by-case basis.³⁴ Studies show that when a conservative approach is taken and significant tooth structure remains, dentists can provide patients with a better prognosis for the restored teeth.³⁴

This classification divides preparation and veneering into reduction (referred to as space requirement, working thickness, or material room), volume of enamel remaining, and percentage of dentin exposed. Notably, classifications I, II—both of which incorporate addition veneers—and III require 70% to 100% enamel periphery.

CL-I

CL-I is the purest form of *no-preparation* or *practically prep-less* veneers, but can include a discreet finish line or only a loupe-detectable margin (Figure 1). The term *addition veneers* frequently describes this preparation design today. In this classification, 95% to 100% of enamel volume remains after preparation, and no dentin

is exposed. Ideal whenever possible, preparation must be completely and only in enamel.

This preparation type can be easily achieved using a bis-acrylic preparation guide created from a putty or silicone matrix of the diagnostic guide wax-up, which can be applied to the teeth.^{49,50} Depth cuts of 0.5 mm for CL-I are placed into the incisal and facial aspects of the bis-acrylic preparation guide, which should result in the depth-cutting bur not touching the tooth, and the clinician should consider removing the aprismatic enamel and placing a practically undetectable finish line (Figure 2 and Figure 3) to aid ceramists in determining margin placement. These depth-cutting grooves minimize potential for over-preparation.

Many times considered the best option because of their tooth structure preservation qualities, prep-less veneers have limitations, including esthetic outcomes. Calamia found that veneers placed with no preparation resulted in periodontal problems as a result of over-contoured teeth that changed the emergence profile.^{2,51} It was concluded, however, that the veneer treatment

TABLE 1

Basis for New Veneer Classification System (Dentin Exposed)

REDUCTION	FACIAL	DENTIN EXPOSED
CL-I No-Prep or Practically Prep-less	Detectable with magnification, with or without gingival finish line	0*
CL-II Modified Prep-less or Minimally Invasive	up to 0.5 mm	10% to 20%*
CL-III Conservative Design	0.5 mm to 1 mm	20% to 50%*
CL-IV Conventional All-Ceramic Design	1+ mm	50%

* Enamel periphery of at least 70%.

TABLE 2

Basis for New Veneer Classification System (Enamel Remaining)

REDUCTION	FACIAL	ENAMEL REMAINING
CL-I No-Prep or Practically Prep-less	Detectable with magnification, with or without gingival finish line	95% to 100%
CL-II Modified Prep-less or Minimally Invasive	up to 0.5 mm	80% to 95%
CL-III Conservative Design	0.5 mm to 1 mm	50% to 80%
CL-IV Conventional All-Ceramic Design	1+ mm	<50%

modality would function long term.^{2,3} To correct the emergence issue, a 0.5-mm reduction restored by 0.5 mm of porcelain provided nearly the original tooth profile with the veneer in place.² Additionally, it was discovered that wrapping the incisal edge enhances strength, and that preparations limited to the facial surface only were not as strong as those with a wrapped incisal edge.^{2,43} This latter veneer preparation type is described below as CL-II.

Some indications for no-prep veneers include peg-laterals, genetic anomalies producing smaller teeth, short and worn teeth, orthodontics leading to a narrow arch, and patients with larger lips. Disadvantages may include limited shade alteration capability, difficulty developing the correct axial inclination, proportional errors, and trouble forming the proper gingival symmetry.^{2,33}

CL-II

CL-II deals with *minimally invasive* or *modified prep-less* veneers (Figure 4). Addition veneers also may fall in this classification. This category should exhibit 80% to 95% volume of remaining enamel, 10% to 20% exposed dentin, and up to 0.5 mm of reduction (Figure 5 and Figure 6). Ideally, CL-II veneers would

have complete enamel periphery, but may involve a small zone on the gingival margin consisting of dentin to clearly establish the restoration margins (Figure 7).⁵² Additionally, 5% to 15% of dentin may be exposed on any facial surface (ie, mesial, distal, or gingival), depending on veneer rotation (Figure 8). To complete a CL-II preparation, a bis-acrylic preparation guide, as previously described, can be used.

CL-III

CL-III is a *conservative preparation* classification (Figure 9) and described as 60% to 80% enamel volume remaining (Figure 10), 20% to 40% dentin exposed, and 0.5 mm to 1 mm of reduction (Figure 11 and Figure 12). With more room for restorative material, the gingival margin will typically involve more dentin.⁵² However, greater than 70% to 80% of the finish line must still be in enamel (Figure 13).

CL-IV

CL-IV is a *full veneer* or *conventional all-ceramic* design (Figure 14) and is best described as approximately 50% of enamel volume remaining, greater than 40% of exposed dentin, and 1 mm or more of reduction. The peripheral margin may consist of only 50% to 70% enamel. Although this veneer preparation

type has become an almost universally accepted technique for placing full veneers, functional and esthetic limitations remain—including lower fracture loads and decreased marginal integrity that ultimately lead to restorative failure.^{53,54} Preparation design and fatigue influence the marginal accuracy of veneers bonded to maxillary central incisors, with significantly higher marginal gap formations developing in complete veneer preparations.^{53,54} Therefore, all limits of restorative options should be considered before undertaking this procedure.

Any given patient could exhibit any combination of classifications due to acidic erosion, genetics, restorative material requirements, occlusion, or tooth- and arch-size discrepancies. As in periodontics, one tooth can be a CL-I furcation and a CL-III in the same dentition, and each has differing treatment approaches, prognosis, and varying care. Again, this veneer classification system was designed to help clarify professional communication and allow patients to better understand how much tooth structure will need to be removed. Such information will enable better informed consent, with patients making the choices they see fit.

When preparations fall outside these parameters (Figure 15), a crown should be *considered* for predictability and longevity.



Fig 10.



Fig 11.

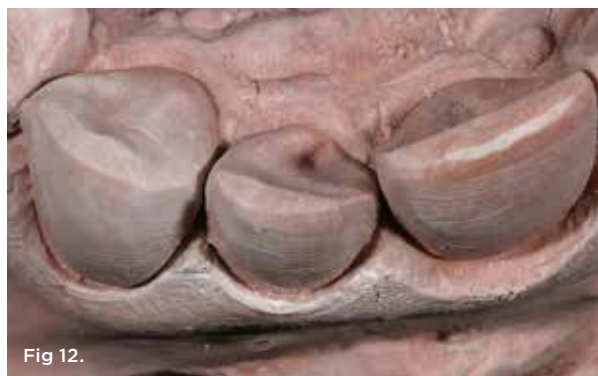


Fig 12.



Fig 13.

Fig 10. Photograph of a conservative Class III veneer preparation design. **Fig 11.** Close-up of the conservative Class III veneer preparation design showing facial reduction of 0.5 mm to 1 mm on the tooth. **Fig 12.** Occlusal view of the conservative Class III veneer preparation design of the same tooth on the die model. **Fig 13.** Photograph of the Class III veneer preparation design demonstrating dentin exposure of approximately 20%, falling within the 20% to 50% range for remaining dentin. Note that more than 70% enamel periphery and 50% to 80% enamel remain, which is a crucial consideration criteria for this classification design.

It is well established that when a tooth that has greater than 50% of enamel missing (Figure 16), moderate sclerotic dentin, and greater than 3 mm of unsupported porcelain, a crown must be considered. Magne found that 65% of a tooth's integrity comes from the cingulum and approximately 27% from lingual marginal ridges.⁵⁵ These anatomical landmarks must be preserved at all costs.⁵⁵ No significant differences in crown flexure were found between natural and veneered incisors when the cingulum is preserved.⁵⁶

However, clinical decisions must be based on the dentist's clinical experience, scientific data, evidence-based literature, the clinical scenario, the patient's desires (ie, time and money considerations), and full consent based on knowledge of advantages, disadvantages, risks, benefits, and prognosis. These factors are significant in treatment selection. CL-I veneer preparation with its 100% enamel substrate is more predictable than CL-IV with its significant dentin exposure.

Conclusion

When cosmetic and adhesive procedures were initially introduced, tissue preservation was the most important goal. With recent paradigm shifts in patient desires and treatment-planning techniques, dentistry is witnessing a resurgence in conservative techniques in day-to-day practice. Although restorations need not be tooth-colored, and gold remains the best restorative material, more patients demand the esthetic potential that tooth-colored restorations demonstrate. To uphold the duty of

nonmaleficence and obtain appropriate consent, dentists must still inform patients of both the benefits and consequences of choosing esthetics over function.

A paradigm shift is essential in dentistry's current thinking regarding veneer preparations. It is no longer acceptable to limit veneer descriptions to no-prep or conventional all-ceramic designs. Proposed are two additional, distinct classifications that should aid dentists and patients in their ability to provide better communication, consent, diagnosis, treatment planning, material selection, education, and tooth structure preservation. Through the clinician's experience and knowledge, the appropriate treatment plan can be selected based on the patient's clinical situation and demands, to give patients the best in function, longevity, and esthetics.

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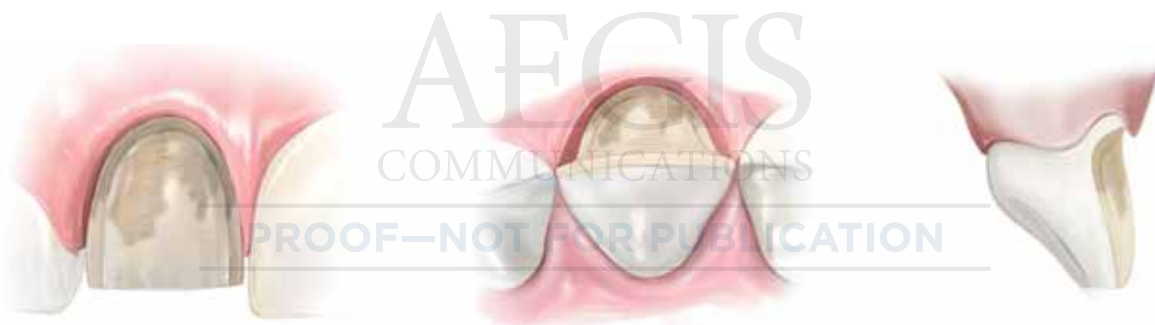


Fig 14.

Fig 14. Illustrations demonstrating Class IV veneer preparations, considered conventional preparations. Facial reduction is typically greater than 1 mm, with less than 50% of enamel remaining and greater than 50% of dentin exposed. Fig 15. Photograph of a conventional all-ceramic restoration preparation design. Fig 16. Close-up of an all-ceramic restoration preparation design demonstrating dentin exposure of more than 50%, less than 50% enamel remaining for bonding, and margins with 30% enamel periphery.



Fig 15.



Fig 16.

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Establishing a Classification System and Criteria for Veneer Preparations

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| <p>1. The cingulum and lingual marginal ridges are significant in that they comprise how much of a tooth's strength?
 A. less than 5%
 B. 20%
 C. 50%
 D. more than 80%</p> <p>2. When properly prepared, what type of substrate provides the most predictable surface to bond porcelain?
 A. dentin
 B. enamel
 C. cement
 D. all of the above</p> <p>3. Minimally invasive dentistry has new technical and educational requirements, and clinicians must stay abreast of:
 A. material selection.
 B. adhesive protocol.
 C. scientific advances.
 D. all of the above</p> <p>4. Expected veneer longevity depends on what, which should be confined to enamel and involve proximal contact areas and functional considerations?
 A. tooth preparation
 B. cementation procedures
 C. the internal restoration surface
 D. esthetic properties</p> <p>5. Defined as the way something is categorized, labeled, organized, distinguished, arranged, or sorted, classification:
 A. creates confusion.
 B. adds clarity.
 C. impedes communication.
 D. results in unnecessary procedures.</p> | <p>6. Which classification category is the purest form of no-preparation or practically prep-less veneers?
 A. CL-I
 B. CL-II
 C. CL-III
 D. CL-IV</p> <p>7. Prep-less veneers are often considered the best option because:
 A. of their esthetic outcomes.
 B. a small percentage of enamel volume remains after preparation.
 C. a high degree of dentin is exposed.
 D. of their tooth structure preservation qualities.</p> <p>8. Which classification category should exhibit 80% to 95% volume of remaining enamel, 10% to 20% exposed dentin, and up to 0.5 mm of reduction?
 A. CL-I
 B. CL-II
 C. CL-III
 D. CL-IV</p> <p>9. Which classification category is a full veneer or conventional all-ceramic design?
 A. CL-I
 B. CL-II
 C. CL-III
 D. CL-IV</p> <p>10. When a tooth has greater than 50% of enamel missing, moderate sclerotic dentin, and greater than 3 mm of unsupported porcelain, what must be considered?
 A. a crown
 B. an implant
 C. extraction
 D. resin cement</p> |
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