An Esthetic Challenge: Isolated Areas of High Translucency in Laminate Veneers

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Abstract

Porcelain laminate veneer restorations are much thinner than other types of restorations such as crowns or onlays. Within the range of 0.3 to 1.5 mm, it is not an easy task for the clinician to provide the appropriate clearance for the ideal restoration and, concurrently, for the dental technician to predictably create a piece of imitated nature. The advantages of enamel preservation and the principle of *nil nocere* imply removing as little tooth structure as possible for the purpose of maintaining tooth health, its mechanical strength and ensure the treatment's long-term predictability. There has to be a balance between the requirements of reduction clearance, which will enable the technician to achieve the desired esthetic result, and the minimally invasive principles of dentistry. With laminate veneer cases, there might be areas of variable ceramic thickness that can create esthetic problems. These will be hard to correct during cementation and will also be clearly visible to the patient. Clinical cases are presented here to outline this type of problem.

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Introduction

Porcelain laminate veneers fabricated out of feldspathic porcelain are a clinically proven treatment option for many esthetic and functional problems in the anterior dentition.[1-11] Different opinions on the ideal degree of tooth reduction coexist: from the non-prep veneers, which can be completely bonded on enamel, to three-quarter partial crowns, which are seated completely on dentin. When veneers were first established in the early 1980s, dentin adhesion was not yet available, and consequently the prevalent principle demanded a shallow preparation with a maximum preservation of enamel.[12-16] With the advent of dentin adhesives and encouraged by the excellent clinical success of such minimally invasive laminate preparations, the depth and the extent of the preparations were progressively increased up to dentin-retained 360 degree veneers that can cover almost the entire clinical crown.[17-20]

Preparation depth for porcelain veneers

Nowadays, no consensus exists on the optimal preparation depth and the amount of enamel needed to be retained. This is also due to the fact that correctly applied contemporary dentin adhesives show a high retention rate. Without doubt, each specific case demands an individualized approach; factors such as the tooth color, desired final shade, tooth position and rotation, existing direct composite restorations, and others will demand corresponding modifications of the preparation and, consequently, of the restoration itself. In our practice, the preparation designs for almost all veneers vary between minimally invasive (100% enamel) to at least 50% retained enamel (Figs 1–4). Enamel is not only valuable because it provides the safest bond to the tooth, but also because it stabilizes and stiffens the remaining tooth structure, therefore lowering the risk of ceramic fractures.[21]

In our opinion, a minimally invasive preparation design is best suited for teeth without heavy discoloration and no need of intricate individualization (Figs 1 and 2). Such veneers with zero or minimum reduction of tooth substance do not allow for the correction of cases with initially oversized or too labially placed teeth. If the porcelain thickness is very low, the “press” technique is not well suited for optimum esthetics; instead, a rather individualized layered technique on platinum foil or refractory die is advisable. When more tooth reduction is possible, it is the aim to provide 0.5 to 1.0 mm of clearance so the dental technician is able to mask the tooth shade and simultaneously allow for internal characterization. For instance, to block an intense dentin shade, especially if the desired final result has a significantly different color saturation and higher value, the veneer fabrication process necessitates multiple layers in different opacities, hues, and values that play specific roles in the overall esthetic outcome, such as: blocking underlying shade, color modification, depth of color, translucency, fluorescence, and others (Figs 3 and 4). Nevertheless, during the tooth preparation, dentin could be exposed in the cervical and proximal-cer-

Fig 1 Minimally invasive veneer preparation in teeth 11 and 21 completely within enamel and feathered edge design. Preparation depth 0.2 to 0.5 mm. Low variability of color on the labial surfaces allows for thinner veneers with minimum characterization.

Fig 2 Thin veneers (0.3–0.6 mm) bonded in place. With the feathered edge design and, in this range of ceramic thickness, only very little internal characterization is possible.

Fig 3 Semi-invasive preparation of teeth 13 to 23. Labial depth approximately 0.5 to 0.8 mm and a 1.5 mm incisal reduction. Dentin exposure cannot be avoided in the cervical third. These dimensions would allow for the masking of discolorations.

Fig 4 The final result with the bonded veneers in place. ~~Veneers~~ fabricated through layered feldspathic porcelain on refractory dies.

vical areas due to the removal of the very thin enamel of approximately 0.2 mm in these regions.[22] In such situations, the use of pressable ceramics and cutback techniques ~~are~~ possible, along with the conventional add-on technique using feldspathic porcelains.

The amount of tooth reduction provided for the ideal restoration thickness is almost never identical with the thickness of the ceramic. Only if the facial surfaces of the teeth needed absolutely no axial or shape modifications would the veneers simply match the preparation clearances. However, in the majority of cases that we encountered in our practice, some changes ~~are~~ necessary through addition or reduction of tooth surfaces. These modifications should be anticipated through the use

of a diagnostic waxup,[23-26] while multiple laboratory-fabricated horizontal and vertical preparation guides can insure the preparation accuracy (Figs 5 and 6).[27-29] Such silicone templates are a proven reliable method to verify the correct tooth reduction and they are used in all of our veneer cases.

To research and demonstrate the efficacy of using diagnostic silicone templates, we proceeded in preparing two extracted maxillary central incisors. One has been conservatively prepared for a porcelain veneer restoration while a silicone template was used to verify the appropriate reduction. The color-coded mapping ~~outlines~~ the reduction differences between the original tooth outline and the final preparation contours. Figures 7 and 8 illustrate how the reduction guides can precisely show the amount of clearance, as long as the template can be securely positioned. For instance, the slightly more aggressive proximal reduction led to dentin exposure on the distal side. The amount of ~~the~~ reduction in relation to the original surface is revealed in the 3D distance map (Fig 8). This demonstrates how difficult it is to create preparations completely in enamel and also the fact that, with the help of a template, it is possible to achieve very conservative preparations.

By contrast, we prepared the second central incisor without the help of a silicone template. The color-coded mapping clearly outlines the higher variability of reduction~~,~~ which, in our case, was reflected in the under-reduced area in the middle of the facial surface (Figs 9 and 10). We recognize that with the freehand technique, it is extremely difficult to produce an even and precise tooth reduction in relation to the prospective labial surfaces (prototyped by the waxup).[26]

The problem

The goal of this article is to emphasize one of the most common types of errors encountered during the laminate veneer procedures. It must be assumed that, due to the miniscule dimensions of these manual tasks, slight deviations from the ideal can never be completely avoided, even with the use of a silicone guide. If the template shifts only slightly from the fully seated position, the preparation may be compromised and precious enamel could be unnecessarily lost. Assuming that the dental technician closely follows the tooth dimensions prototyped in the waxup, insufficient tooth reduction could be reflected into areas of esthetically compromised ceramic veneer. Over the years, ~~in our practice, we have received~~ many porcelain veneers with transparent areas due to insufficient thickness and/or wrong layering technique ~~from different dental laboratories~~. When such a laminate is bonded to the tooth, a dark spot becomes visible in the area where the tooth has been under-reduced. This spot clearly appears brown-orange with rather high chroma, possibly due to the color contrast with higher value of the surrounding porcelain, or the combined optical effects created by the bonding resin and the underlying tooth color. In cases where clear bonding resin was used, the spot appears darker than the dentin shade beneath the veneer (Fig 11). In the specific case presented in Figure 11 (feldspathic porcelain ve-

Fig 5 Waxup on plaster model with the horizontally cut silicone template. The palatal section allows for checking for the template's passive fit.

Fig 6 The template of Fig 5 seated in the mouth. Teeth 12, 21, 22 veneer preparations approximately 0.8 mm depth, tooth 12 crown-preparation ca. 1.6 mm depth.

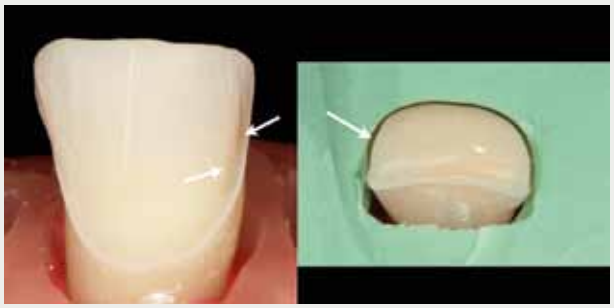

Fig 7 A veneer preparation on an extracted right maxillary central incisor with the aim to stay completely within enamel. Slightest deviations (± 0.1–0.2 mm) from the ideal can lead to unwanted dentin exposure.

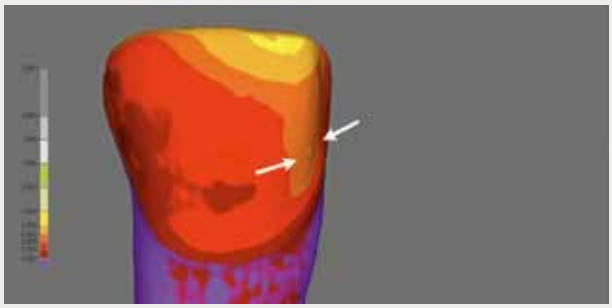

Fig 8 Color-coded 3D distance map generated by the comparison of the original outline and the prepared surface of the tooth in Fig 7. It indicates the preparation depth (software: Geomagic Studio).

Fig 9 Freehand preparation on an extracted left maxillary central incisor without the help of any silicone template.

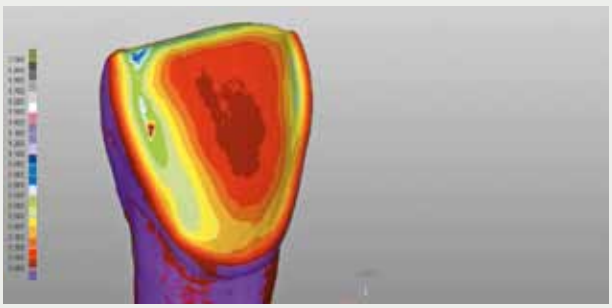

Fig 10 Color-coded 3D depth map generated through the comparison of the original outline and the prepared surface of the tooth in Fig 9. The central area is reduced only minimally (software: Geomagic Studio).

Fig 11 Teeth 11 and 21 restored with feldspathic porcelain veneers fabricated through layering on refractory dies. On tooth 21 the area with high chroma (orange-brown shade) and low value is clearly visible in the center.

Fig 12 Original situation of the case in Fig 11. The tooth 21 was rotated and slightly protruded. With the objective of not losing too much enamel this obviously led to a borderline preparation.

neers bonded to teeth 11 and 21) the cause has been identified as the insufficient reduction of the rotated tooth 21 (Fig 12), while the dental technician attempted to achieve an ideal arch alignment for the labial surfaces of 11 and 21. The excessively thin ceramic did not allow for a layer of masking, opaque dentin porcelain. Figures 13a and b, and 14a and b are schematic representations of the issue described.

All the "spotted" veneers were subsequently removed and their bond to the underlying structures assessed. The assumption that an air bubble was caught beneath the veneer did not justify the altered esthetic effect because it does not create such an intensely chromatic modification. This was also confirmed by the fact that in 100% of these cases, the veneers were tightly bonded beneath the dark spot and no voids were detected. However, all of them showed porcelain transparency in the corresponding area before bonding. It was also found that, in these specific cases, the dental technician set a higher importance on replicating the prototyped

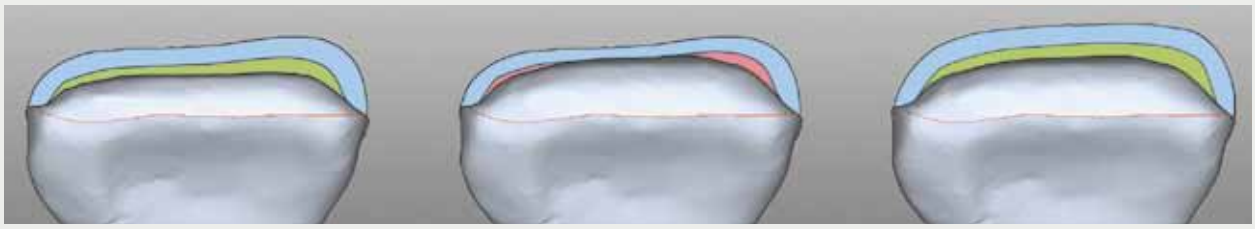

Fig 13 Incisal views of different configurations: **a)** Sufficient tooth reduction allows for a complete masking layer of opaque ceramic (green) and consequently blocking the underlying shade. **b)** A localized area of insufficient clearance may result in a spots of missing masking layer (where red disappears) as long as the technician adheres to the original outer shape. **c)** As in **b),** the preparation is not perfect, but the technician modifies the volume of the tooth in order to accommodate the appropriate esthetics and assures the presences of a complete masking layer (green).

wax shape rather than applying a sufficient and uniform masking layer on the veneer's intaglio surface, which consequently would ~~also~~ alter the final outline. In most cases, silicone templates were used during porcelain layering and, in order to obtain the necessary space for the outer enamel layer, too much of the deeper, more opaque layers were partially removed.

All veneers that are supposed to block the underlying shade must show a uniform opaque/masking effect, except in the cervical area, where a contact lens effect could be desired. In most cases, the shape modifications are so slight that it is possible for the technician to set the priority on completing the blocking layer and subsequently increase the porcelain volume or slightly alter the contour of the tooth in the problematic area (Figs 13c and 14c)

Another example is shown in Figure 15, where both veneers showed transparent areas to a different degree. After bonding, the described optical effect was apparent on both teeth (Fig 16). In our experience, the central aspect of the facial surface is the typical location for this problem. This is due to the fact that the natural incisors' anatomy is often slightly concave in the middle of the labial surface, right in between the facial-proximal transition lines. As clinicians sometimes tend to apply the full-crown preparation principles to veneer preparations, they produce convex stumps in this area.

Another interesting case we encountered was where the provisional restorations misled the clinician due to the fact that acrylic material had a superior opacity than porcelain. As a result, while

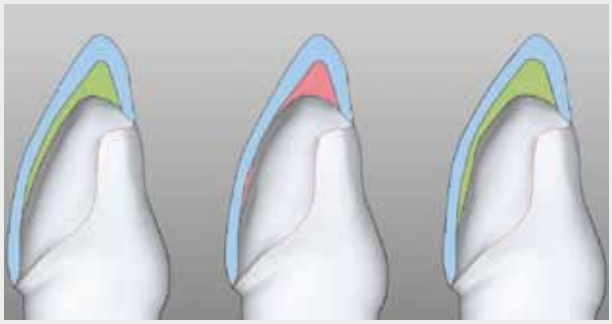

Fig 14 The same cases as in Figure 13 – sagittal dimension.

Fig 15 Two ceramic veneers with central transparent areas.

Fig 16 The veneers of Figure 15 after cementation. The darker stump shade bleeds through the transparent spots.

Fig 17 Original situation, veneers planned on the four maxillary incisors.

Fig 18 Preparation template in the mouth. Narrow space mesio-labially at tooth 21 and direct facial of tooth 11.

Fig 19 Chairside provisionals (Luxatemp A2, DMG, Germany). The prepared teeth's shade is sufficiently masked.

Fig 20 The stump of tooth 21 is also slightly darker. Veneers on the lateral incisors are in place for try-in.

the chairside provisional restorations fabricated using a waxup generated a transparent matrix that successfully blocked the underlying dentin shade, the porcelain that was fabricated at a similar thickness with the provisionals did not successfully block the dentin shade (Figs 17–22). Looking back at the preparation stage, we realized that tooth 21 was insufficiently reduced mesio-labially (Fig 18). The black marks on the preparation guide indicate that, during preparation, these areas were already outlined, marked as critical spots, and also reduced. Ultimately, in the attempt to preserve enamel, there was still in-

Fig 21 The porcelain veneer of 21 exhibits the problematic central transparent area.

Fig 22 Veneers at try-in (Variolink Veneer try-in 0 - transparent, Ivoclar Vivadent). The orange spot in the middle of facial surface is obviously bleeding through.

Fig 23 Some tooth structure was removed in the corresponding area in question and a more opaque/higher value luting composite (Variolink Veneer HV +3) was used with the intention of masking. The result is not perfect. Both the lighter composite and residual dark areas are visible.

Fig 24 Another clinical case with problematic areas of insufficient clearance, mainly due to concave shape characteristics of the waxed-up contours.

sufficient reduction on tooth 21. Due to the slightly darker stump shade of tooth 21 (Fig 20), and in combination with the transparent area of the veneer (Fig 21), the brown spot appeared at the try-in. The translucent part of the veneer consisted mainly of an enamel porcelain. It was then attempted to slightly relieve that specific area of the tooth and mask it *ex post* with a higher opacity/higher value composite resin (Variolink Veneer HV +3). The result was still deemed unsatisfactory (Fig 23). It is very difficult to predict the final shade and overall esthetic outcome by using various levels of opacity and value for resin cements.

Fig 25 In this case, the final result shows no undesired chromatic spots as the dental technician took particular care to achieve a uniform opaque layer by slightly altering the veneers' contours.

Solution

Above all, dental practitioners need to make sure enough clearance for the chosen ceramic thickness is provided, so the dental technician can properly layer the required amounts of ~~ceramics.~~ The space required varies from case to case depending on the indications. When tooth discolorations are to be masked, it is advisable not to attempt performing extreme minimally invasive preparation designs. The use of a diagnostic waxup and preparation guides is highly recommended.

In our opinion, the complete masking of underlying shades takes precedence over the prototyped contours, and slight modifications of the final restoration outline can be acceptable. The example shown in Figures 24 and 25 illustrates a case where, in spite of the low clearance situation, it was still possible to create uniformly masking veneers. Usually, only a few tenths of a millimeter of additional ceramic are sufficient in avoiding the transparent area effect. This way, the situation can be solved without a visible compromise for the patient in regard to the shape of the teeth and also without

the necessity of additional preparation and impression steps. Another option is to remove material on the master die and fabricate a reduction coping (eg, made of resin) that will guide the dentist in removing the same tooth structure volume as on the master die, right before bonding the veneer otherwise fabricated on the altered die. Depending on the location and size of the low clearance area, this method does not always work well and it can be risky with respect to the seating precision. In our opinion, the best solution is, upon patient approval, to proceed with the corrective tooth preparation and new impression. It is to be expected that, in the near future, intraoral digitizing devices will allow for a real-time reduction in assessment during the preparation stages.

Conclusion

It is important for the clinician to always aim for a uniform and sufficient tooth reduction, not measured from the original tooth surface, but from the planned result prototyped in a diagnostic waxup. The use of a silicone template is a predictable technique and should be used for every veneer case. Special care should be taken in avoiding uneven surfaces that can lead to areas of insufficient clearance. The dental technician should be informed to absolutely avoid any transparent spots in the ceramics unless located in the cervical junctional areas. The unfavorable esthetic effect of the transparent window and its modalities of prevention should be well communicated between the clinician and the dental laboratory, especially on plaster models; even on tooth-colored stumps (eg natural die material, Ivoclar Vivadent) the final color cannot be reliably predicted.

In European countries, the literature suggests that most patients still prefer tooth shades within the range of A2 to A3 (Vita Classic) and with a certain degree of translucency for a more natural depth of color. In other parts of the world, highly influenced by the patient's esthetic perception and the cultural/social environment, more opaque and bleached shades in the range of 0M1 to 0M3 (Vita Classic) are demanded.[30-32] In such cases, due to the very high value and low chromatic individualization combined with the use of highly filled/opaque resin cements, the esthetic issues outlined in this article do not occur as often.

In esthetic dentistry, excellent results that get as close as possible to the perfection of nature can only be achieved when both the dental practitioner and the dental technician understand the possibilities, the requirements, and limitations of each other's work.

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