Modifications to Class II GV Black Preparations for Composite Resin

by Dr. Peter Walford, DDS, FCARDP

This article follows a previous article titled "Design Principles for Composite Class II Preparations," published in Oral Health December 2012. This article will further illustrate the clinical rendition of the five axioms guiding enamel preparation, and the five axioms guiding dentin preparation, to optimize Class II composite preparations (Figs. 1 & 2).

CLASS II ISTHMUS AND OCCLUSAL SURFACE

No change from GV Black (GVB) method is required on the occlusal surface. Rods are inherently transected and fresh-cut, obeying enamel axioms #1 through #5. If the occlusal surface has abundant secondary grooves, which are likely to lead to flash that cannot be removed with finishing burs, these areas should be sandblasted so that flash will be well-bonded where it cannot be finished, thus observing enamel axiom #1.

SHOED AND REPLACED CUSPS: SELECTIVE BEVELS

Shoed cusps are usually placed in thick enamel. As seen in Figures 3 and 4, the number of rod-ends engaged by bevels of varying angles correlates to enamel thickness. Very thick enamel, as found in the coronal third of the tooth, contributes abundant rod-end exposure and requires minimal bevelling (only six degrees). Initial reduction with a fissure bur to a consistent depth of 1.5-2 mm follows penetration cuts into the triangular ridge made with a 330 carbide bur (Beaver Jet, Sybron Kerr) (Fig. 5). This follows dentin axiom # 3. The shoe-margin is idealized to a linear, finishable margin with a carbide 7406 12-bladed finishing bur (Beaver Jet, Sybron/Kerr) (Fig. 6). Either the bur taper or the incident handpiece angle controls the extent of bevel. As the shoe descends, the lingual or buccal wall, and enamel thins, the bevel is increased until it reaches 45 degrees at the CEJ (Fig. 4). A greater bevel of 60 degrees is beneficial only anteriorly, where cosmetic blending is paramount.

"WET-PACK" PLACEMENT TO PRODUCE A FLAWLESS CORONAL MARGIN

The key to an invisible shoe or 45 degree bevelled margin (Figs. 7 & 8) is to extrude a small amount of flowable composite resin against a bonded and matrixed finish line, brush it to place, and then remove most of the flowable by cleansing the brush on gauze. Without curing the flowable, the final resin is placed and "wet-packed" to close the shoe-margin. Any flowable expressing into the main body of the restoration is also removed by a brush and then cured. Reducing the volume of flowable admixed with the restorative resin sustains the best physical properties for the final restoration.

This method is only indicated where gingival access is safe and space is available for rotary final finishing, as it readily generates overhang and flash. Interproximally it is unsound.

45 DEGREE CHAMFER BEVELS FOR CEJ GINGIVAL MARGINS IN LARGE LESIONS, MODBS, OPEN AND LARGE CLASS II BOXES:

Often, near the CEJ (Figs. 7 to 12), a 45-degree bevel using a 7406 bur becomes inaccessible. Instead, it can be placed using a tapered crown preparation diamond with a "curettage" profile, like a 0816.08C (Neo Diamond), (Fig. 9). This diamond cuts quickly with a light touch. The prep is then polished with a matching profile crown finishing carbide, H284K.018, (Brasseler) (Fig. 10), to eliminate fractured enamel rods. This margin is very effective as a finish line in the buccal margin of a MODB (Figs. 11 & 12) or lingual margin of a MODL (Figs. 13-17). This 45-degree bevel meshes with the need to withstand high contraction forces developed by a large mass of contiguous resin, relative to a smaller remaining amount of tooth structure (enamel axiom #5). Despite careful incrementing, crazing and white lines may be seen with lesser bevels. A 45-degree margin near the CEJ consumes little extra facial surface and produces maximum rod-end bonding surface area while developing a pleasing aesthetic transition from resin to tooth. Near the occlusal

1. Always fresh cut
2. Always rod ends
3. Always a bevel
4. Thickness for wear
5. Thickness for contraction

FIGURE 1—Enamel axioms.

1. Always fresh cut
2. Rounded internal form
3. Consistent depth for esthetics
4. Sufficient depth for loads
5. Form to spare the bond

FIGURE 2—Dentin axioms.

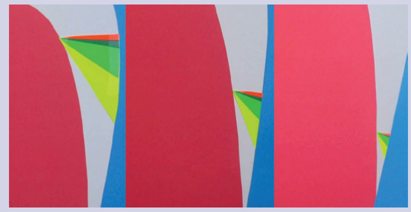

FIGURE 3—Bevels of 6, 12, 45, and 60 degrees located at different heights of the clinical crown.

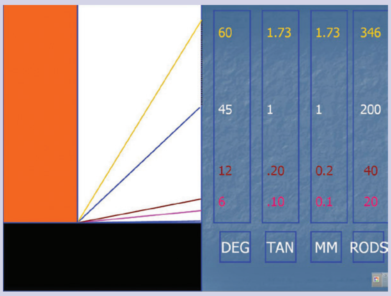

FIGURE 4—Bevels and respective tangents, cavosurface footprint and rods consumed.

FIGURE 5—Depth cuts with 330 bur for consistent cusp shoeing.

FIGURE 6—Shoed cusp bevel imparted with 7406 bur.

FIGURE 7—MOL preparation with 45 degree lingual bevel.

FIGURE 8—MOL restoration with "wet-pack" placement.

FIGURE 9—45-degree bevel made with 0816-016 diamond.

surface, the footprint of a 45-degree bevel is needlessly destructive to enamel (Fig. 3). "Wet-pack" placement of 45 degree margins is again beneficial.

60 DEGREE MARGINS

60 degree margins, sometimes titled "Infinite Margins", are intended for aesthetic facial-surface blending. Near the CEJ in posterior teeth, there is little aesthetic gain from a 60 degree bevel relative to 45 degrees. As bevels become steeper, one begins to face the difficulty of adapting resin to a fine, acute-angled matrix-to-tooth interface, with resultant bubbles and voids. Wet-pack placement is effective, but better outcomes with 60-degree or greater bevels are attained freehand before matrixing.

CLASS II BOX

The clinical goals in the Class II box are to: establish bevelled enamel margins, open proximal contact without iatrogenic risk, conserve enamel, place margins that are restorable with conventional sectional matrixes, and promote safe final finishing. With sectional matrixes, this usually means that the box margins cannot be significantly past the line angles.

WHAT IS THE CORRECT BEVEL FOR THE PROXIMAL WALL?

What instrumentation should be used for the Class II proximal walls to meet these goals? The choice of bevel for proximal walls rides a tightrope. Sufficient box width is needed to safely break contact, permit finishing with discs, burs, or hand instruments, and create a bevelled rod-end box wall, as per enamel axiom #3. Insufficient width frustrates proper bevelling or definitive instrumentation, probably shortening restoration life, while excess width consumes tooth unnecessarily and exposes margins more visibly.

An ideal bevel, meetingaxiom #3, would be six degrees; see previous article for more discussion on this point. In enamel 1 mm thick, compared to an equivalent amalgam, just breaking contact by hand instrumentation to a butt margin,

FIGURE 10—45-degree bevel polished with Brasseler 286K.018.

FIGURE 11—MODBs with 45-degree margins at CEJ.

FIGURE 12—MODB with 45-degree margins at CEJ.

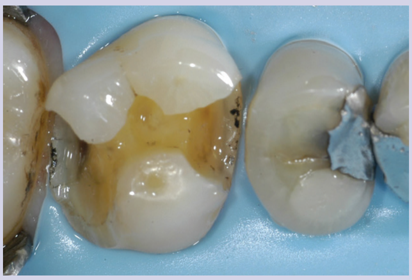

FIGURE 13—MODL preparation after amalgam removal.

FIGURE 14—MODL margins cleaned up.

FIGURE 15—Disto-lingual 45-degree margin being placed with H284K018 bur.

FIGURE 16—Matrixed preparation.

FIGURE 17—Finished restoration.

FIGURE 18—Bevelling walls of incipient box with disc.

a six-degree proximal wall widens the box proximally by 0.1mm. The rationale, geometry, and calculations behind this are discussed in the previous article "Design Principles for Composite Class II Preparations" (also see Fig. 4).

Two methods for bevelling conservative proximal walls are described below: "Discs" and "Outside-in cutting."

INCIPIENT BOXES: HAND INSTRUMENTS AND DISCS

The narrowest box extension can be achieved by thinning the marginal ridge with a fissure bur internally and breaking contact with hand instruments. Then, a stiff plastic backed disc (3M Soflex, medium grit) is used to impart a bevel of six degrees to the box wall, working form the gingival/proximal line angle to the occlusal (Fig. 18). A moderate speed (6000 rpms) is used in a contrangle, with two-handed guidance for safety, and care to avoid disc binding and running wild (Fig. 19). Note that enamel in the proximal box becomes thinner as the gingivo-proximal line angle is approached. Therefore it cuts more readily by disc than does the thicker enamel wall near the occlusal surface. The gingival bevel developed is therefore often greater than that achieved towards the occlusal.

This is a desirable correlation between technique and outcome. More rod-ends are exposed at the bottom of the wall, the gingival-proximal line angle, which is a weak and vulnerable site. The time required for discing is less than a minute per restoration.

FIGURE 19—Two-handed stabilization of disc.

FIGURE 20—Initial cut of "outside-in" cut at occlusal portion of box.

FIGURE 21—Second cut of "outside-in" cut.

FIGURE 22—Third cut of "outside-in" cut at level of gingival margin.

FIGURE 23—Appearance of boxes after "outside-in" cutting.

FIGURE 24—Wide boxes cut with 1157 bur.

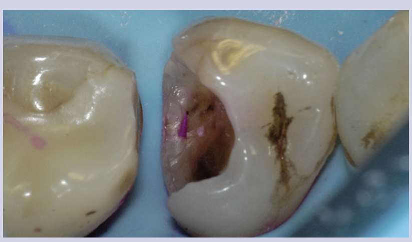

FIGURE 25—Caries at gingival margin.

FIGURE 26—Irregular margin after preparation with 1157 bur.

FIGURE 27—56 bur entering box to plane gingival floor.

MEDIUM BOXES: "OUTSIDE-IN" BEVELLING WITH 169L BUR

When caries drives the proximal box wall further towards the line angles, but not to the extent that a 1156 or 1157 fissure bur (Jet Beavers, Sybron/Kerr) can clear contact, a 169L bur (Jet Beavers, Sybron/Kerr) can be used to break contact. Rather than cut from inside the preparation, the bur is placed externally at the desired exit point of the wall, beginning at the occlusal extent of the box, and cutting obliquely towards the excavated inner form (Fig. 20). The apical third of this bur (0.35 mm in diameter), is significantly smaller than 56 series burs at 1.0mm diameter. It cuts the least box extension possible with today's rotary armamentarium. Its major advantage is that it sidesteps the iatrogenic potential incurred by the inverse approach (cutting outwards from inside the preparation). There is no risk of inadvertent contact with the adjacent tooth. A recent study in Clinician's Report, November 2012, found that fully 40 percent of adjacent teeth are nicked or damaged during Class II preparations with conventional technique.

One or two successive cuts are made, dropping towards the desired gingival depth, using the apical third of the bur. While aiming at the excavated cavity, contact can be broken safely and the wall defined (Figs. 20-22). The typical extension after "outside-in" cuts are made, is shown on the mesial of the bicuspid in Figure 23. Note that to reach the cutting efficacy experienced with larger diameter burs, this very fine bur needs to be extremely sharp. Once dull, considerable pressure is needed, negating the safety of this approach. Both a new bur and a concentric

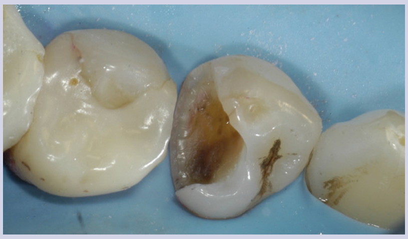

FIGURE 28—Finished gingival margin after planing.

FIGURE 29—Off-angle H6/7 scaler upscaling gingival margin in "contraction-driven gingival instrumentation."

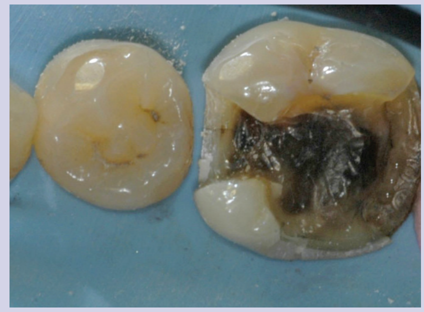

FIGURE 30—Weak interproximal enamel rods cleaved off by upscaling.

FIGURE 31—15-year x-ray of "contraction-driven" gingival margins.

FIGURE 32—Low-modulus first gingival increment.

FIGURE 33—2 and 3.5 mm cure test samples.

handpiece are needed to optimize safety. The 1169L bur is inferior to the 169L for tactile control of this step, so that the proximo-gingival line angle is rounded by other means. Time required for "Outside-In" cutting is less than a minute per restoration.

LARGE BOX, BEVELLING WITH 1156/7

When a previous restoration is wide enough to pass a fissure bur such as a 1156 or 1157 (Beaver Jet, Sybron/Kerr), a bevelled wall can be cut (Fig. 24) either "Outside-In", or "Inside-Out". This takes no longer than conventional treatment.

GINGIVAL FLOOR FOR INCIPIENT OR MODERATE LESION: CONTRACTION-DRIVEN INSTRUMENTATION

The final surface to discuss is the ginival floor. Box preparation begins as per GVB technique with an 1157 bur. The proximal walls are cleared by any of the modes discussed above. The gingival floor is established in dentin at the desired height, but the gingival enamel is left un-cut, as illustrated in the mesial box of Figure 23.

This uncut interproximal enamel is broken out with a scaler or hand instrument, and this "ragged" gingival floor is now planed with a 56 bur. Planing is carried out with care from wall to wall, which may have residual CEJ caries as revealed by caries detector (Kuraray) (Fig. 25), and is often uneven following the use of a dome-ended fissure bur. While dome-ended burs create round internal form, reducing internal stress (dentin axiom #2), they are not effective in safely defining a clean linear gingival margin. Prior to planing, the floor may not be a consistent plane, and may have weakened remaining enamel (Fig. 26). The 56 bur (Fig. 27) inserts into the smallest of boxes and reaches the gingival margin without extending interdentally to risk unwanted iatrogenic contact with the adjacent tooth. Thereby a clean and linear gingival margin at 90 degrees to the long axis of the tooth is easily and safely attained. There is little chance of the bur falling off the floor apically into the gingival embrasure and there is also limited risk of contacting the adjacent tooth. The resultant gingival margin (Fig. 28) is not bevelled. Enamel axioms #2 and #3 are therefore violated.

However, in small- to- moderate boxes, no known rotary bur safely imparts a 6 to 12 degree bevel to the gingival floor. Any bur with a bi-bevel tip of 6 to 12 degrees is too large in diameter to effectively instrument an incipient box or to safely approximate the adjacent tooth. Conversely, any bur small enough to be safely interposed risks unwanted excursions off the gingival margin towards the gingival.

GINGIVAL BOX: THEORETICAL DESIDERATA

For theory to meet practice, an ultrasonic tip, safe-sided, trapezoidal in outline, approximately 0.75 mm thick with a fine diamond coating, could finish both proximal and gingival margins safely at a bevel between 6 to 12 degrees. A minimum of two tips would be necessary, one mesial, one distal, with perhaps small and larger versions. This instrument could place the desired bevels on the gingival margins, and, if the sides were also abrasive, it could define and impart a bevel to the proximal walls. Unfortunately, thus far, ultrasonic instrumentation (Kavo Soniflex) has been developed only for indirect procedures with far greater bevels (25 degrees gingivally and 30 degrees proximally), which are unnecessarily destructive for conservative direct preparations.

Once a corrected device is developed, theory and practice will finally mesh at the gingival margin like two halves of a zipper. In the interim, the following technique is expedient and has shown minimal gingival re-decay over a fifteen year period in clinical practice. The author gives the term “contraction-driven gingival instrumentation” to this technique.

Using a sharp H6/7 (off-angle sickle scaler) from beneath the margin (Fig. 31), the integrity of the gingival margin is challenged by upward strokes, attempting to collapse enamel rods into the box, mimicking forces of polymerization contraction. In clinical practice, fragile rods are seen to break free by these upward strokes, even after a conventional GVB margin trimmer has been used (Fig. 30). Any resultant defects in the margin are re-planed with the 56 bur and again up-scaled. Typically, after several rounds of this protocol, the floor robustly survives more up-scaling. It has become a consistent, matrixable line, and does not shed more rods. Less than a minute is required to instrument gingival enamel with this technique, using efficient CDA four-handed methods to alternate between 56 bur and off-angle sickle scaler.

From a theoretical framework, however, this method clearly fails to achieve end-bonded rods, achieving only robust rod sides. Enamel axioms #2 and #3 are being violated. Is this good enough? This author would argue, from clinical observation over many years, that it is adequate (Fig. 31), but it can be improved upon. A companion restorative protocol, a “low-modulus lock-down,” mates with this theoretically compromised preparation and has been followed to minimize the effects of resin contraction.

FIRST INCREMENT: LOW-MODULUS LOCK-DOWN

What method of resin placement should be used to restore the gingival enamel margin to avoid “separation” of the enamel rods (cohesive destruction) or “peel” (adhesive destruction) of the resin-enamel interface? A small, low-modulus (highly elastic) first increment complements the fragility of the unbeveled gingival enamel. This is accomplished by using a very thin layer of flowable resin (0.25 mm thick) on the gingival margin and all box internal surfaces (Fig. 32). This layer is completely cured — at double the usual increment cure time — before final resin is added.[1] The gingival margin is thereby reinforced and locked down structurally against excessive contraction. Why is this indicated?

Analytically, dentin is “slightly flexible” at 12 GigaPascals (GPa). Enamel, at 80 GPa is brittle. Flowable resins typically have an elastic (flexural) modulus of 6GPa, which is 50 percent that of dentin. Final resins typically have an elastic modulus in the range of 8 to 12 GPa, approximately equal to dentin, ie., often twice as stiff as flowables. Elastic modulus varies enormously among resins and flowables (Table 1). A suitable Class II first-increment flowable delivers 6GPa, twice as elastic as dentin, twice as elastic as typical hybrids/nanos and 13 times more elastic than enamel. From this understand-

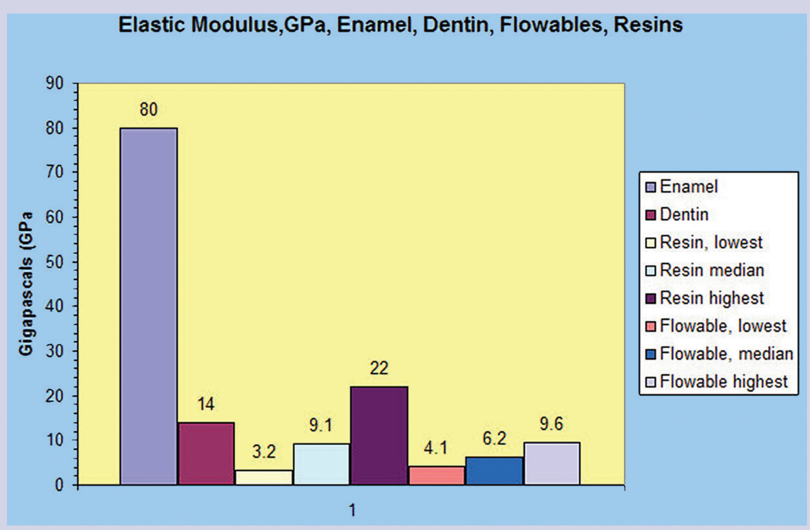

TABLE 1

ing of elastic modulus, depending on product, it is clear that final resins are generally more hazardous as a gingival first increment. Elasticity data can be obtained from manufacturers by request.

The flowable increment ties together all the spatial elements in the bottom five percent of the box — gingival enamel, gingivoproximal enamel, gingival dentin, axial dentin, and proximal dentin, with the least contraction possible. To mitigate high polymerization contraction (typically 4.5 percent), flowable volume should be minimized. Note that two walls are open, lowering C-factor.

This unifying elastic increment, volumetrically small, protects the thin and fragile gingival and external line-angles by luting them to the contiguous dentin box. This increases bonded area by a large factor, dissipating subsequent increments into all box elements, protecting fine enamel against both "separation" and "peel."

It should be noted that other components of a sound composite protocol contribute to success. Liquid 37 percent phosphoric acid etch is at the 95th percentile of effectiveness in the field of etchants,[2] and is a superior cavity cleanser than gel etchants. Other lifespan-enhancing methods include: a dentin primer containing BAC to resist MMP degradation of hybridized collagen,[3] a very hydrophobic adhesive with a robust degradation curve established after six years of thermocycling,[4] resins heated to 54°C reducing shrinkage and increasing physical properties,[5] and curing at 2200 mW for double normal cure times with a deeply penetrating plasma-arc curing light (Sapphire Curing Light, Denmat) to ensure maximum photoconversion.[6] An extended gingival curing time overcomes light intensity fall-off as tip-to resin distance increases.[1] Many flowables require longer curing times, even at short distances. This is verifiable by chairside test cures at 2-3.5 mm criterion wafer thickness (Fig. 33). Finally, beyond 6mm of box depth, a dual-cure flowable[6] is substituted for light-cure, overlying a dual-cure adhesive with known compatibility.[7]

These techniques are critical to optimizing outcomes, but do not take the practitioner greater time. The author believes that failure to control for many of the above parameters contributes to enormous data spread in longitudinal studies of Class II survival. Fuller discussion of these aspects unfortunately lies outside the scope of this article.

DISCUSSION

Following the methodology detailed in this article, a sound preparation in harmony with defensible axioms can be developed for Class II composite resin restorations. A departure from theory in the gingival margin is noted and pragmatically overcome, but further development in instrumentation is needed to improve the mesh of theory to practice.

In this writer's opinion and experience, a well-isolated, correctly matrixed preparation mated to a suitable final resin, and definitively cured, delivers a satisfactory lifespan from a composite restoration of virtually any size or complexity. However, with the divergence of current direct techniques within the profession, and the wide range of resin parameters, more reliability is currently achieved with indirect methods. Unfortunately, in North America, many patients will never be able to afford indirect dentistry. The bulk of the undeveloped world will also never receive laboratory-based restorations. What do we offer these patients today?

There is a need for the dental profession globally to elaborate a consensual technique for composite resin. Standardization of method is required to guarantee a standard of care. The preparation is the logical starting point in the journey to consistency and longevity, and suffers no product variability. The preceding concepts, instrumentation, and process have proven reliable in the hands of the author and members of his study clubs, and are offered for professional debate and further research. **OH**

Dr. Peter Walford, DDS, FCARDP, McGill 1975, www.peterwalforddentistry.com is in private practice in British Columbia and mentors study clubs in composite resin technique. Contact pwalford@telus.net

Oral Health welcomes this original article.

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