Cavity design for Class IV composite resin restorations – a systematic approach

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Abstract

A definitive cavity design, without pins, that enhances retention and resistance form for simple and complex Class IV composite restorations is proposed. An extracted tooth model and diagrams illustrate the incisal step 45° bevel design for simple cavities and the incisal step veneer bevel design for complex cavities. A case report of a complex Class IV composite restoration is presented.

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Introduction

It is accepted that most retention form (resisting a vertical withdrawing force) for a Class IV composite resin restoration is developed from numerous micro-mechanical attachments gained after etching enamel.[1] However, resistance form (resisting apico-oblique forces) has not been widely addressed.[2] Consequently, some composite resin fractures[3] at the incisal edge, and dislodgement[4] of the restoration, have often been entirely blamed on poor physical properties of the resin or mismanagement of the etched enamel respectively.

It has been suggested that the external cavity outline for the acid etched composite resin restoration should be butt jointed[5] while others recommend bevelling of the cavo-surface margin in the form of either short,[2,6] long,[7] chamfered,[8] chamfer shoulder,[9] concave[10] or feathered bevels.[11] Incisal reduction has largely been considered as being unwarranted, with a feathered margin from the internal cavity outline to the incisal edge cavo-surface margin[6,9,11] being the preferred conservative approach. As well, the design of cavities with sufficient surface area of etched enamel and resisting walls and floors has not been adequately investigated.

The purpose of this paper is to produce a methodology of cavity preparation that optimizes resistance form for Class IV composite resin restorations.

Cavity design

The aims of the proposed cavity preparation are:–

1. To produce sufficient bevelling of enamel in a mesio-distal direction, so that the approximate area of etched enamel is equal to that external area of missing enamel prior to bevelling (Fig. 1a, b, c).

2. To provide deep labial and lingual enamel bevels that oppose each other so that the resultant thickness of composite resin is capable of resisting labio-lingual rocking forces (Fig. 1c, d).

3. To reduce the incisal edge uniformly and to a depth whereby the resultant inciso-gingival thickness of composite resin is capable of resisting destructive incisal forces and prevent premature loss of the incisal edge by wear (Fig. 1a, b, d).

4. To produce a butt joint at the incisal edge cavo-surface margin and an incisal step to help prevent flaking of the composite resin at the incisal edge cavo-surface margin (Fig. 1a, b).

5. To provide flat floors at the incisal edge and gingivally that provide the restoration resistance to apically directed forces (Fig. 1a, b).

Incisal step 45° bevel

This conservative design is employed for simple Class IV cavities, that is, those with minimal mesio-distal loss of tooth structure that are subject to low to moderate incisal forces (Fig. 2a).

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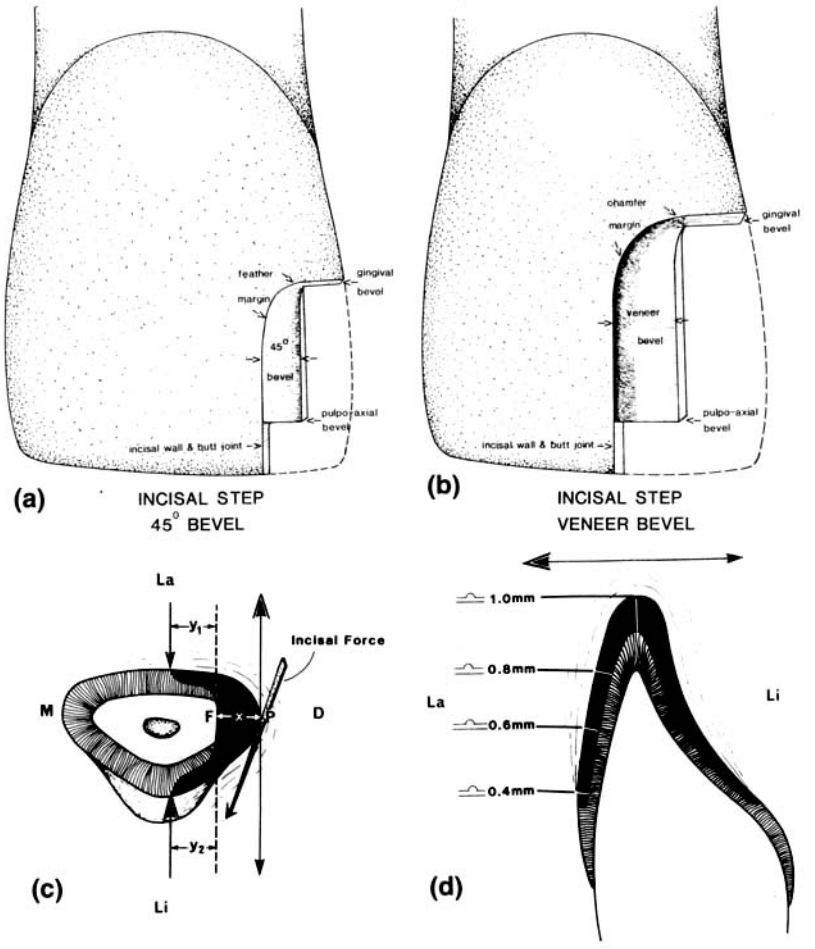

Fig. 1.—a, Diagram of a labial view of a central incisor with an incisal step short 45° bevel Class IV cavity preparation used for small mesio-distal width cavities.
b, Diagram of a labial view of a central incisor with an incisal step veneer bevel Class IV cavity preparation used for larger mesio-distal width cavities.
c, Diagram of a cross-sectional view of an incisor tooth restored with composite resin (black) prepared with veneer bevels and subjected to labio-lingual rocking forces (arrows). Note the mesio-distal width of etched enamel (y) is approximately equal to the width of missing tooth (x). It can be hypothesized that for a force (P) the distance (y) of the veneer bevels should be equal or greater than (x) to confidently maintain equilibrium of the restoration (black).
d, Diagram of a longitudinal view of a maxillary central incisor tooth restored with composite resin (black) prepared with veneer bevels and subjected to labio-lingual rocking forces (arrows). Note the veneer bevels are approximately half-thickness enamel reductions and therefore are graduated depths from an incisal to gingival direction.

After caries removal, labial and lingual 45° bevels approximately 1 mm wide (mesiodistally) and 1 mm deep into enamel are placed (Fig. 2b). The labial bevel is neatly cut with a 1.4 mm diameter flame diamond[12] (medium grit) bur;† but, to achieve a deep internal cut into the enamel on the more inaccessible and concave lingual surface, the bevel is placed with a 2.5 mm diameter bullet shape diamond (mediun grit) bur† (Fig. 2c). Incisal reduction is performed with a 0.9 mm diameter cylindrical diamond (medium grit) bur† producing a step approximately 1 mm deep (inciso-gingivally) and 1 mm wide mesiodistally (Fig. 2d). The cylinder diamond bur is further used to flatten the gingival floor to approximately 1 mm (mesiodistally).

†**Horico.** Hopf, Ringleb & Co. GmbH & Cie, Berlin, West Germany.

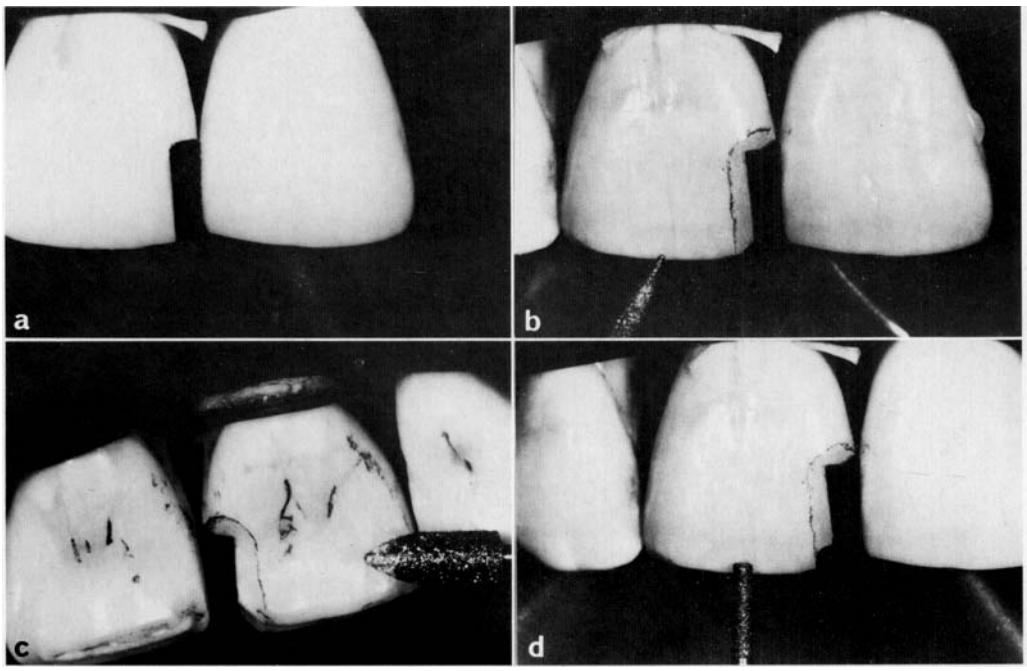

Fig. 2.–a, Labial view of extracted teeth 11 and 21 illustrates a simple Class IV cavity on the mesial of the 11 after caries removal, flattening the gingival floor and straightening the axial wall.
b, Labial view of the extracted tooth 11 cavity reveals the labial bevel (pencilled) with the flame diamond used to cut a 1 mm wide (mesio-distal) 45° bevel.
c, Palatal view of the extracted tooth 11 cavity reveals the lingual bevel (pencilled) with the bullet diamond used to cut a deep 45° bevel.
d, Labial view of the 11 cavity reveals the incisal step with an 0.9 mm diameter cylinder diamond used to cut an approximately 1 mm deep (inciso-gingivally) step and to verify the mesio-distal width of the labial and lingual bevels. Note the gingival bevel and pulpo-axial bevel completes this incisal step 45° bevel preparation.

Finally, the flame diamond bur is used to lightly bevel the gingival floor enamel and to harmonize this with the labial and lingual bevels, incisal step and pulpo-axial angles. The gingival outline is not bevelled if this would result in a sub-gingival location or if the anticipated cavo-surface margin ends in dentine[13] or cementum.[13] Instead, the butt joint is retained. If a butt joint is placed, and further retention and resistance is required, a small groove may be placed in dentine at the axio-gingival line angle with a round 0.6 mm diameter bur.[13]

Incisal step veneer bevel

This design circumvents the need for pins and is employed for complex Class IV cavities, that is, those that are wide mesio-distally and/or subject to high incisal forces or have a history of repeated failures (Fig. 3a).

After caries removal, labial and lingual bevels are placed of sufficient width to correspond to the mesio-distal loss of tooth structure (Fig. 3b). These veneer bevels are graduated depth cuts into the incisal third (0.8 mm), middle third (0.6 mm) and gingival third (0.4 mm) of the enamel, with the result that approximately half of the thickness of the enamel layer is removed (Fig. 1c, d). The labial bevel is achieved with a 1.2 mm diameter torpedo diamond (medium grit) bur.‡ An initial 0.6 mm cut can easily be estimated by engaging half the diameter of the bur in the enamel and using the tip and side of the bur to form a chamfered cavo-surface margin (Fig. 1c, d). The lingual bevel is similarly prepared by the bullet shape diamond bur. The incisal and gingival reduction is performed as above for the incisal step 45° bevel design so as to harmonize with the veneers (Fig. 3c, d).

Case report

Examination

A thirty-eight year old man was referred because of repeated loss of composite resin restorations from

‡**Komet.** Lemgo, West Germany.

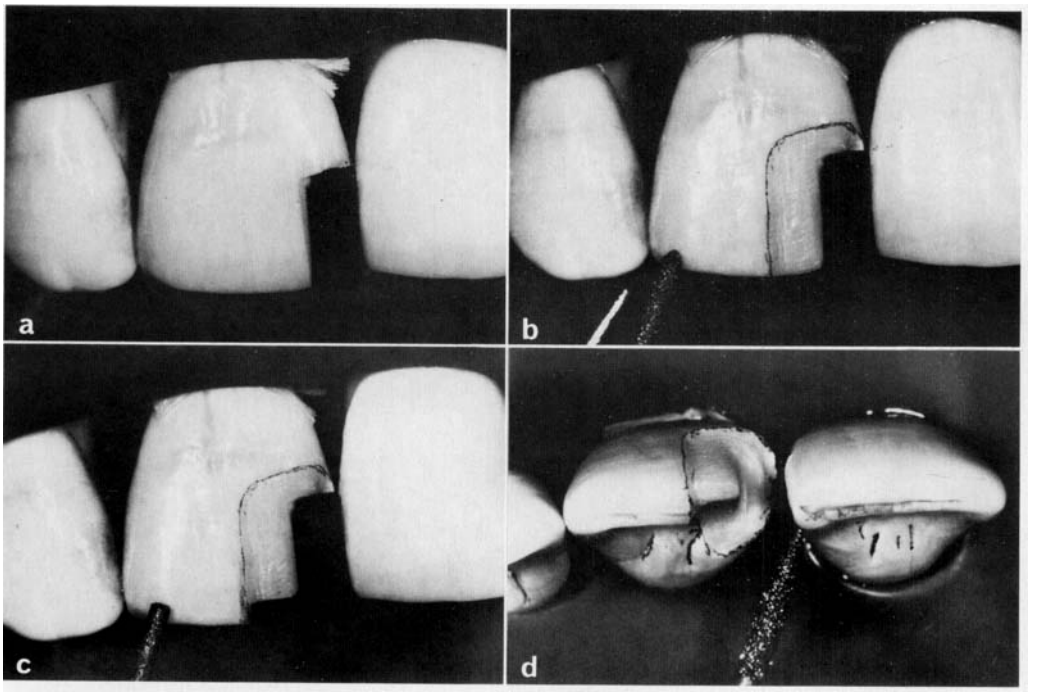

Fig. 3.—a, Labial view of extracted teeth 12, 11 and 21 illustrates a moderate size Class IV cavity on the mesial of the 11 after caries removal, flattening the gingival floor and straightening the axial wall.
b, Labial view of the 11 cavity reveals the labial bevel (pencilled) with the 1.2 mm diameter torpedo diamond used to cut deep, approximately half enamel thickness, veneer bevels ending in a chamfer.
c, Labial view of the 11 cavity reveals the incisal step with an 0.9 mm diameter cylinder diamond used to cut the step, pulpo-axial bevel and flatten the gingival floor.
d, Incisal view of the 11 cavity reveals the completed incisal step veneer bevel preparation with the flame diamond used to cut the gingival bevel (pencilled).

the mesio-incisal surfaces of 41. He requested either a 'white crown' or restoration that 'wouldn't fall off'.

The cavity preparation revealed an 0.5 mm wide (mesio-distally) labial and lingual 45° bevels with a curved gingival floor (Fig. 4a). A functional occlusal analysis revealed that lateral occlusion was cuspid guided, with disclusion of other teeth. Protrusive occlusion was guided by upper and lower central incisors, along a smooth and straight path with disclusion of other teeth. There was no evidence to suggest acute clenching or bruxing habits. However, the patient was a confirmed, predominantly left-handed, nail biter. A history revealed that five attempts to restore the tooth with a 'white filling' had occurred in the last four years. The patient had never before seen a rubber dam.

Treatment

An incisal step veneer bevel preparation was prepared as above, and a rubber dam was securely placed using clamps§ on the 43 and 33, and a dental floss ligature on the 41 (Fig. 4b, c). A base‖ was placed, enamel pumiced and etched in the recommended manner, and the 41 was restored with composite resin** (Fig. 4d).

The occlusion was checked with articulating paper in all excursions and the composite resin adjusted until it was just free of the occlusion but with the distal half of the incisal edge of the tooth maintaining the centric stop and protrusive guidance. The patient was asked to refrain from nail biting on that tooth or to use minimal force. The restoration four years following treatment is intact, despite continuing nail-biting.

Discussion

The above described incisal step 45° and veneer bevel designs have been taught and used by dentists

§No. 00. Ash Co., Weybridge, UK.
‖Procal. 3M, Minnesota, USA.
**Visio-dispers. ESPE, Seefeld, West Germany.

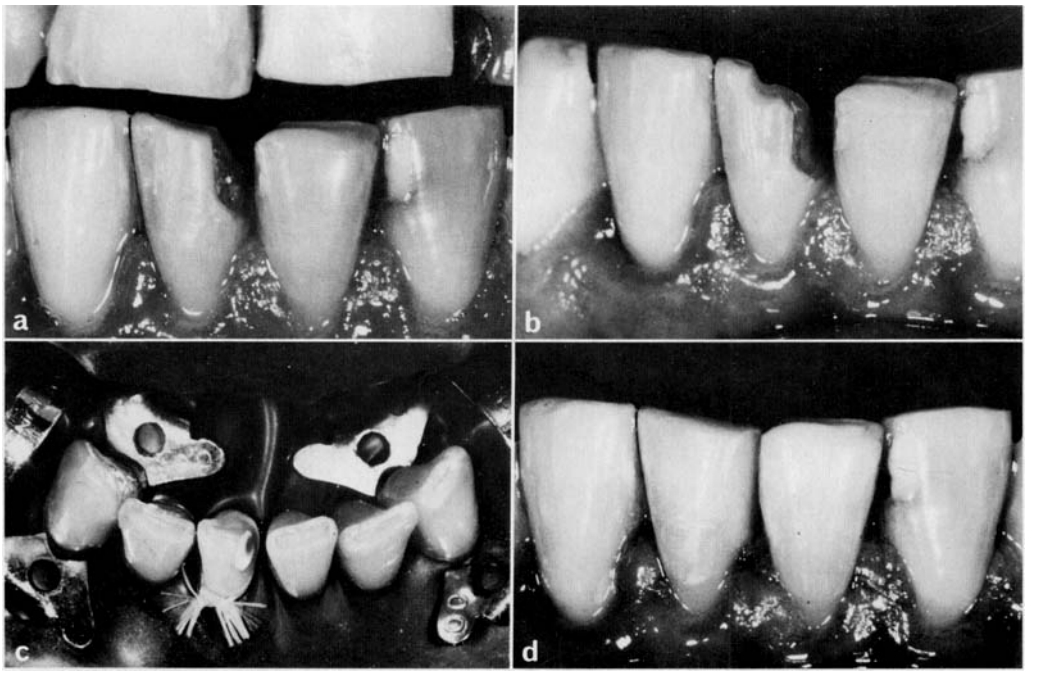

Fig. 4.–a, Labial view of the non-retentive and non-resistive Class IV cavity of the 41 reveals a small labial bevel and curved gingival floor.
b, Labial view of the prepared 41 Class IV cavity illustrates the incisal step, labial veneer bevel, flat gingival floor and pulpo-axial and supragingival bevels.
c, Incisal view of the etched Class IV cavity illustrates a simple rubber dam technique used for isolation.
d, Labial view of the 41 illustrates the completed Class IV composite resin restoration.

at four participating continuing education courses at this Dental School and found to be sound and effective. Potentially, these preparations can make it possible to avoid the use of pins with their inherent disadvantages of shadowing of the pin, unless opaqued, through the composite resin, loss of the composite resin resulting in exposure of the pin, pulp and periodontal ligament exposures, cracking of the tooth, and weakening of the restoration. As the incisal step preparation allows a bulk of resin at the incisal edge, wear can occur without premature loss or gross chipping of composite resin at an otherwise bevelled incisal edge cavo-surface margin where the resin would be thin and attenuated.

It is recommended that for Class IV cavity preparations a rubber dam should be accurately placed[14] to avoid contamination of the acid etched enamel. As well, the veneer bevels must be deep (almost half of the enamel layer thickness) and not thin and attenuated. Otherwise untoward flexing and wear of the composite resin could result in restoration failure.

This incisal step veneer bevel design is essentially a partial veneer crown preparation. Although its preparation may appear to be destructive it is more conservative of tooth structure than a full veneer crown. Aesthetically, most patients prefer this larger 'white' restoration to a big inlay. As well, these cavity designs can easily be incorporated with any dentine bonding technique used in Class IV restorations.

Conclusion

The incisal step 45° and veneer bevel preparations for the acid etch composite resin restorations discussed are designs that have been used without pins, allow supragingival margin placement, offer resisting walls to prevent restoration dislodgement by apico-oblique forces and provide incisal bulk to help prevent gross chipping of composite resin at the cavo-surface margin on the incisal edge.

The theoretical and technical appreciation of the designs are shown in line diagrams and extracted tooth models along with a case report demonstrating a satisfactory clinical result.

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