A scanning electron microscopic investigation on the acid-etched cervical margin of Class II cavities

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The use of composite resin as a restorative material for Class I and II cavities is becoming more common. The marginal leakage at the proximal cervical margin of Class II composite resin restorations remains a major limitation to the widespread acceptance of this material. Although somewhat controversial, beveling of the cavosurface line angle has been suggested as a way to enhance the bond at the cervical margin that finishes on enamel. The acid-etched appearance of beveled and nonbeveled enamel at the proximal cervical margin of Class II cavities was studied under the scanning electron microscope. The results appear to support the efficacy of the beveling of this margin for Class II composite resin restorations. (Quintessence Int 1990;21:299-302.)

Introduction

Since its introduction in the 1950s by Buonocore, the acid-etching technique has been the most effective means of bonding restorative resins to dental enamel. The bond achieved is a form of micromechanical retention by the penetration of the resin into the micropores, hence the “resin tags” in the treated enamel surface. This technique is widely employed and forms an integral part of modern restorative procedures for composite resin restorations.

The primitive type of cavity preparation for direct resin restorations was a copy of that for silver amalgam, with a 90-degree butt joint at the cavosurface line angle. Although it has been shown that etching and applying an unfilled resin to the enamel on the cavity wall reduces the microleakage around the restoration, some investigators recommend modifications of this butt joint marginal finish for composite resins. Beveling of the cavosurface angle, which is generally advocated currently, was one of the proposed modifications. It was reasoned that a cavosurface bevel would give an increased surface area and a better orientation of enamel rods for acid etching, and hence a better bond and marginal adaptation.

In a number of microleakage studies, researchers were unable to demonstrate a significant improvement in the marginal leakage pattern around composite resin restorations with a change in the cavosurface design. All restorations in these experiments had their margins finished entirely in enamel. This prompted the question of whether beveling of the cavosurface line angle would provide any significant improvement in the bond achieved with the acid-etching technique.

Because an increasing number of composite resin materials are being marketed for use in posterior Class I and II restorations, it was the purpose of this study to examine the effect of placement of a bevel at the proximal cervical margin of Class II cavities on the morphology of the enamel surface after acid etching.

Method and materials

Ten extracted teeth, five premolars and five molars, were stored in 10% neutral formalin. The teeth were gently scaled to remove any gingival tissue and plaque that were attached.

A box cavity was prepared in one of the proximal surfaces of each tooth using a high-speed tungsten carbide bur. The box measured approximately 3 mm in buccolingual width and 1.5 to 2.0 mm in depth. The cervical margin of the cavity was finished about 1 mm above the cementoenamel junction with a sharp hand instrument (Wedelstaedt chisel) to a butt joint. Half the length of this margin was then beveled with a fine-grit diamond at high speed to give a 45-degree cavo-
surface angle (Fig 1). The cavity margin was etched with a 35% phosphoric acid gel for 1 minute, rinsed with water for 30 seconds, and blown dry.

Impressions were taken of the cervical cavity margin, before and after the acid-etching procedure, with a rubber-based elastomeric material. The positive replicas, poured in epoxy material and sputtered with gold particles, were examined under a scanning electron microscope.

Results and discussion

Typical scanning electron micrographic appearances of the cavity margin with the two different finishing procedures are shown in Figs 2 to 4.

Hand instruments invariably produced severe smearing of the prepared surface (Fig 3). Under the air-water spray coolant, the fine-grit diamond bur gave a fairly clean surface, although scratches were evident on the surface (Fig 4). These findings were similar to those observed by Leidal and Tronstad, Barnes, Crawford and Wittaker.

The treatment of the prepared surface with diluted phosphoric acid completely removed the smear layer. In addition, the acid dissolved the enamel rods differentially, producing an irregular, microporous enamel surface, the so-called etching pattern. The appearance of this pattern depends on the orientation of the enamel rods prior to acid treatment. In the present study, all butt joint finishes demonstrated a fairly smooth and homogenous appearance on most of their
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Figs 5a to 5c  Etching pattern obtained on butt joint cavity finish.

Fig 5a  Typical etched appearance of longitudinally sectioned enamel rods found on most of the enamel surface of the butt joint margin.

Fig 5b  Well-defined etching pattern found in part of a butt joint margin.

Fig 5c  Occasional patches of Class 1 and 2 etching patterns observed in an otherwise longitudinally sectioned enamel rods.

Fig 6  Well-defined Class 1 and 2 etching patterns in all beveled enamel margins.

surfaces (Fig 5a), which is typical of the etched topography of longitudinally sectioned enamel rods.\(^\text{319}\) Only one specimen, a molar, revealed a well-defined Class 1 and/or 2 etching pattern (Fig 5b) that was comparable to that obtained on the beveled enamel surface (Fig 6). A premolar tooth showed patches of class 1 and/or 2 etching pattern in an essentially smooth surface (Fig 5c). These results seem to agree with the statement that the direction of enamel rods is variable at the cervical region of the enamel near the cementoenamel junction of a tooth.\(^\text{313}\)

At the beveled margin, typical and well-defined Class 1 and 2 etching patterns were obtained in all cases (Fig 6). It appears that beveling of the margin in this area improved the orientation of enamel rods for acid-etching, contrary to the conclusion of Retief et al.\(^\text{2}\) Presumably, if an unfilled resin is applied on the etched surface, a better bond is likely to result at the beveled margin than at the butt joint margin, provided that no other factors intervene. However crazing or fracture of enamel may still be caused by contracting restorative resins that bond well to the etched enamel wall.\(^\text{21}\)

Conclusion

The present study indicated that beveling of the cervical enamel margin of the proximal box of Class II cavities would result in an oblique orientation of enamel rods in this area, and hence a better etching pattern after acid conditioning. This would, presum-
ably, result in a better bond with restorative resins than would occur at the butt joint margin, if all other factors related to bonding were favorable.

Acknowledgment
The author would like to thank his colleague, Dr. A. Dimmer, for her advice in preparation of the manuscript.

References

Periodontal Control
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