

New quantitative measuring technique of microleakage through 3D reconstruction of the restored tooth

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I. Objectives

Microleakage tests using existing methods have their own disadvantages. In this study, a novel method of 3D reconstruction of restored tooth was used to overcome those kinds of disadvantages.

The relationships among the results of 4 kinds of methods were estimated: penetrated dye volume from 3D reconstruction; quality of marginal adaptation from SEM; 2 dimensional degree of dye penetration and relative penetrated length to cavity wall.

II. Material and Methods

24 Class V cavities were bulk filled with hybrid composite, Esthet X (Dentsply Caulk, Milford, DE, U.S.A.) after surface treatment in three ways: N group (no treatment); E group (etching only); T group (etching + Prime&Bond NT).

Restored teeth were dye penetrated with 50% silver nitrate after thermocycling (5-55°C, 1,000 times) and 2-times nailpolish covering except 1 mm area around restoration: immersed for 10 hours, after then, fluorescent light was used for 10 hours. Teeth were dipped in a developing solution for 2 hours.

After imbedding teeth in an autocuring resin, they were serially ground with a thickness of 0.2 mm. Images of each cross-section were taken with a digital camera. 3D-DOCTOR (Able Software Corp., U.S.A.) was used for reconstruction of restored tooth from serial modified ground images with a Photoshop. Volume of dye penetration was estimated from a reconstructed image.

Resin replica was made with a polysulfide rubber impression material and polyurethane die material shortly after thermocycling. After gold sputtering, percentage of perfect margin was estimated from SEM image (x 1,000).

Degree of dye penetration was evaluated from each 2 dimensional ground surface image and the relative dye penetrated length to a cavity wall was also estimated.

Three kinds of statistical analysis was used: ANOVA and Scheffe test for dye volume, Kruskal-Wallis & Mann-Whitney test for marginal quality, Spearman's rho test for checking of relationships among 4 methods.

III. Results

1. Enamel margin was more resistant to dye penetration than dentin margin. Areas of dye penetration could be seen from several directions including from outer and inner surface, furthermore, its volumetric estimation was possible.
2. T group which followed the manufacturer's recommendation showed the best results in penetrated dye volume and the marginal quality, the next was E group filled with treatment of etching only. N group filled without any surface treatment was the worst. All properties of N group was significantly different from those of T group (volume: $p=0.011$ / marginal quality: $p=0.002$), however, E group was not different (volume: $p=0.551$ / marginal quality: $p=0.093$).
3. Reverse relationship was found between the dye volume and the marginal quality ($r^2=-0.881$ / $p=0.004$).
4. In spite of the number of vertical section, very low relationship was seen between dye volume, marginal quality and 2 dimensional evaluation ways (degree of dye penetration / relative length of dye penetration to a cavity wall) in T group. However, methods of 2 dimensional evaluation showed high relationship ($p=0.002-0.054$) each other.
5. Although there was no difference in the results of 2 dimensional evaluation ways according to the number of vertical section, method of 3-time section could be recommended from its middle rank.

IV. Conclusion

Within the results of this study, it was revealed that volumetric dye penetration could be inferred from the result of marginal quality, not from the result of 2 dimensional evaluation methods. Method of 3-time section could be recommended as a representative section number.

A novel 3D reconstruction method used in this study may be useful in a more detail volumetric estimation of microleakage.