Effect of nonvital tooth bleaching on microleakage of resin composite restorations

Rahmat A. Barkhordar*/Daniel Kempler**/Octavia Plesh*

Abstract
Thirty-six extracted, noncarious, nonfractured human incisors were divided into four groups of nine teeth. Endodontic access cavities were prepared, the pulp chamber was debrided, the root canals were cleansed, and root canal treatment was completed. Pulp cavities of teeth in group 1 received a cotton pellet and were sealed with Cavit. Groups 2, 3, and 4 received a mixture of 30% hydrogen peroxide and sodium perborate for 3, 4, and 7 days, respectively, were sealed with Cavit, and were stored in a humidor until used. Cavit and the other materials were removed, and the cavities were rinsed and restored with Scotchbond Multipurpose and Silux. The teeth were thermocycled, stained with 50% silver nitrate, and sectioned longitudinally. Dye penetration was measured. Results indicated that bleaching adversely affected the marginal seal at the tooth-restoration interface, as evidenced by increased microleakage: the highest rate of microleakage was found after the 7-day application of bleaching materials. (Quintessence Int 1997;28:341-344.)

Clinical relevance
The technique of nonvital bleaching with 30% hydrogen peroxide and sodium perborate may adversely affect the seal of resin composite restorations.

Introduction
Nonvital tooth bleaching has been shown to be an effective and conservative technique. However, research has shown that, to a varying degree over time, bleached teeth have regressed in color. Color regression may be due to access of fluid into the bleached and restored cavity. Because nonvital bleaching is followed by esthetic restoration, one of the prerequisites is that the esthetic restoration prevent microleakage. Utilization of modern dentin-bonding agent and resin composite systems has improved the seal at the tooth-restoration interface. However, little is known about how bleaching will affect the microleakage of the newer resin composite materials.

Previous reports have shown that the combination of hydrogen peroxide and sodium perborate, used in nonvital bleaching, is capable of breaking down into active oxygen, which fractures complex molecules into shorter molecules. Therefore, the presence of active chemicals may have an effect on the resin-bonding restorative technique that follows the bleaching process. One aspect that may be affected is the seal at the resin-tooth interface. The present study has been undertaken to assess the effect of nonvital tooth bleaching on the microleakage at the tooth-resin composite interface.

Method and materials
Thirty-six extracted, noncarious, intact human incisors were selected. Endodontic access cavities were prepared to a diameter of 3 mm, and the contents of the

* Associate Professor, Department of Restorative Dentistry, School of Dentistry, University of California, San Francisco, San Francisco, California.
** Visiting Professor, Department of Restorative Dentistry, School of Dentistry, University of California, San Francisco, San Francisco, California.
Reprint requests: Dr Rahmat A. Barkhordar, Endo Division, Room D212, School of Dentistry, University of California, San Francisco, San Francisco, California 94143-0758.
pulp chambers and root canal system were removed by endodontic instrumentation up to file No. 25. The canals were irrigated with 1% sodium hypochlorite.

The teeth were divided into four groups of nine teeth each. Sodium perborate was mixed with 30% hydrogen peroxide and placed into the cavities, which were sealed with Cavit (ESPE-Premier) and stored in a humidor at 37°C. The groups were treated as follows:

Group 1: cotton pellet, no bleach for 7 days (control)
Group 2: bleaching for 2 days
Group 3: bleaching for 4 days
Group 4: bleaching for 7 days

At the elapsed time, Cavit and bleaching material were removed, and the cavities were rinsed with saline and air dried. The cavities were treated with Scotchbond MultiPurpose dentin-bonding agent (3M Dental) and restored with Silux Plus (3M Dental). The restorations were cured for 40 seconds and finished and polished with Sof-Lex disks (3M Dental). The restorations were placed within 2 to 4 hours of the end of the bleaching process.

All four groups of teeth were thermocycled at 5°C to 60°C for 2 hours at 1-minute intervals in each water bath. The teeth were removed and dried. The roots were then sealed with nail varnish to ensure sealing of tooth surfaces except cavity margins. Each tooth was immersed, occlusal-side down, in separate containers of 50% silver nitrate and 50% tap water for 2 hours. The teeth were then rinsed with tap water and placed in developing solutions overnight.

The teeth were rinsed and sectioned longitudinally with a fine diamond disk at low-speed (Isomet, Buehler). The depth of dye penetration was measured with a dissecting microscope (Bausch & Lomb) with a measuring micrometer eyepiece at x30 magnification.

The microleakage was measured, in millimeters, as the linear depth of penetration from the external portion of the cavity to the deepest apical extension of dye along the wall. The differences among the four groups were evaluated with analysis of variance with Tukey contrast at the 95% confidence level.

Results

Figures 1 to 4 show a representative tooth from each group. The amount of staining by silver nitrate increased with the increase in bleaching time.

Table 1 shows the mean values of microleakage for the unbleached group and the three groups submitted to different lengths of bleaching. There were statistically significant differences in leakage among the groups ($P<.001$); the unbleached group showed the least leakage. Contrast between paired groups revealed significant differences between the control group and the 4-day and 7-day bleaching groups, but no difference between the control group and the 2-day bleaching group. Therefore, only beyond 2-day (4- and 7-day) bleaching was there a significant increase in microleakage ($P<.001$).

Under the conditions of the present study, the bleaching material had a minimal effect on the marginal seal of the resin composite restoration within the first 2 days and a significant effect after 4 to 7 days of bleaching.

Discussion

The results of this study showed that hydrogen peroxide-sodium perborate bleaching has an adverse effect on the seal at the tooth-restoration interface. These findings are in agreement with those of previously published reports on the deleterious effect of bleaching on bond strength between resin composite and restorative resin.$^14$-$^19$

The reduction in bond strength of hydrogen peroxide-treated teeth has been considered to be located at the enamel-bonding-resin interface as a site of failure.$^14$ An increase in surface porosity and formation of a surface precipitate has been reported with an increase in bleaching time.$^{15,16}$ Hydrogen peroxide has been suspected to cause denaturation of proteins in the
organic components of dentin and enamel, altering the organic-inorganic ratio with an increase in inorganic component. However, the exact changes induced by bleaching agents on the enamel and dentinal surface morphology remains to be established.14,15,19

The present results also showed that the micro-leakage, assessed by the silver nitrate staining, increases with increased bleaching time. The silver staining procedure selected has been previously demonstrated to provide a sharp picture of penetration that can be easily measured.20 A direct correlation between bleaching time and bond strength also has
been previously demonstrated. The size and number of unattached areas between resin and bovine enamel were found to be significantly increased as a function of time of exposure to hydrogen peroxide.

Therefore, the present results corroborated those of other published studies, showing that bleaching has a deleterious effect on the tooth–resin composite interface. Whether the hydrogen peroxide alters the tubular permeability and interprismatic area, facilitating the persistence of peroxide at length, remains to be established. Residual hydrogen peroxide has been reported after water rinses. The same study also showed that enzyme application must be employed to remove all traces of the bleaching material from the pulp chamber.

Thus, it seems that a resin composite restoration should be placed within 2 days to minimize the effect of the bleaching agent on the resin composite’s bonding properties. Also, the role of enzyme application in eliminating traces of hydrogen peroxide not eliminated by water rinses should be investigated.

Conclusions
This in vitro study indicated that nonvital tooth bleaching with 30% hydrogen peroxide and sodium perborate adversely affected the seal at the tooth–restoration interface, as evidenced by increased microleakage. The longer the application time of the bleaching materials in the pulp chamber, the more marked was the microleakage. The highest rate of microleakage was observed after 7 days. It may be concluded, therefore, that the bleaching should not be performed for longer than 2 days and that complete elimination of the possible traces of the bleaching material should be attempted.

References
5. Howell RA. The prognosis of bleached.