Effect of nightguard vital bleaching gel on the color stability of provisional restorative materials

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ABSTRACT

Purpose: To assess the hypothesis that there was no difference in effect of 10% and 15% tooth bleaching agents on color stability of materials used for provisional fixed dental prosthesis.

Methodology: Fifteen samples from two materials used for provisional fixed dental prosthesis: methacrylate-based and composite-based materials and 15 preformed polycarbonate crowns soaked in bleaching gel or distilled water. Spectrophotometer recorded color of specimens at baseline, after 3, 7, and 14 days. Data were statistically analyzed using two-factor ANOVA test to compare the color stability of tested materials.

Results: Methyl-based provisional material exhibited statistically higher color change when exposed to 10% and 15% bleaching gel (delta E*: 9.0 and 11.1, respectively) as compared to distilled water (delta E*: 2.9). Delta E* of composite-based material specimens exposed to distilled water was statistically higher (6.3) than specimens exposed to 10% and 15% bleaching gel (1.5 and 1.1, respectively). Polycarbonate crowns showed a statistically lower color change when exposed to 15% (0.9) than to 10% bleaching gel (5.1) or distilled water (5.5).

Conclusions: Composite-based provisional material showed highest color stability when exposed to vital tooth bleaching gel, whereas methacrylate-based material was the least color stable. Polycarbonate crowns were more color stable when exposed to 15% bleaching gel as opposed to 10% bleaching gel.

Key words: Crowns, dental prosthesis, provisional, tooth bleaching

Prosthodontic procedures usually involve placement of provisional restorations on natural teeth or abutments of dental implants to protect the teeth and their periodontal structures, to maintain their relationship with the adjacent and opposing dentitions, and to fulfill esthetic demands of the patient.[1-3] Materials used to fabricate provisional fixed dental prosthesis include thermoplastic acrylic (polymethyl methacrylate, methyl methacrylate, ethyl methyl methacrylate, butyl methacrylate, or vinyl ethyl methacrylate),[4,5] bis-acryl composite materials,[6-10] and visible light-activated resins.[11-13] Preformed provisional polycarbonate or cellulose acetate crowns can be used for anterior teeth, whereas ready-made aluminum and stainless steel crowns can be used for posterior teeth.

Sometimes, extensive restorative clinical cases might necessitate the use of provisional fixed dental prosthesis for longer periods of 5–6 months. These cases include but not limited to healing of gingival tissues after periodontal surgery of the teeth in the esthetic area, osseointegration of dental implants, and cases of occlusal rehabilitation. During this wait time and before the fabrication of the proposed final crowns or fixed prostheses, bleaching of the remaining natural teeth that were not prepared might be anticipated.[4] In such cases, it is sometimes difficult to limit the exposure of the bleaching gel to the natural teeth only...
and to protect the provisional crowns from the bleaching solution. Some yellowish or orange discoloration of the provisional restorations was observed during vital tooth bleaching procedures.

Nightguard vital bleaching is a well-documented conservative procedure to lighten sound teeth, and carbamide peroxide (CP) is an accepted material where, under the dentist supervision, the patient can apply the agent in a custom-fitted soft plastic tray. Braun and Jepsen concluded that although higher concentration bleaching agents might whiten the teeth faster (in 3 days), after 1 week of daily vital bleaching, similar effects can be achieved with both a high and low concentration solution.

Color stability of provisional materials in normal oral environments has been found to be acceptable for short periods. These restorations tend to discolor when used longer than 5 weeks. In 1979, Crispin and Caputo found that methyl methacrylate was the most color stable followed by ethyl methacrylate and then vinyl methacrylate materials. In 1980, Yuodelis et al. reported that after 1 month, methyl methacrylate was more color stable than bis-acryl-based composite materials.

However, studies on color stability of different provisional materials against vital tooth bleaching are limited in the literature. In 1997, Robinson and Haywood found that while methacrylate-based provisional materials turned orange when exposed to 10% CP bleaching solutions, bis-acryl composite provisional material, and polycarbonate crowns showed no change in color.

The purpose of this study was to evaluate the color stability of three provisional fixed dental prosthetic materials when exposed to 10% and 15% CP vital tooth bleaching solutions. The hypotheses were (a) there were no differences in color stability among the provisional materials tested and (b) there were no differences in color stability among the solutions tested.

**MATERIALS AND METHODS**

Fifteen discs, 10 mm in diameter and 2 mm thick, were fabricated from the same shade (A2) of two provisional restorative materials: polybutyl methacrylate (Trim Plus, Harry J. Bosworth, Skokie, IL, USA) and bis-acryl resin composite (Luxatemp, DMG America, Englewood, NJ, USA) using two silicone molds.

The discs were placed between two polypropylene sheets (Temporary Splint Material, Buffalo Dental Mfg.) under a 5 kg weight and allowed to cure under normal atmospheric conditions in the laboratory.

3M™ abrasive band (Gesswein Inc., Bridgeport, CT, USA) was used to remove the superficial layer of the set material. Surfaces of the specimens were polished using fine flour of pumice (Whip Mix Corp., Louisville, KY, USA) and white diamond (Kerr Corporation, Orange, CA, USA). Fifteen polycarbonate crowns were sectioned mesiodistally to produce relatively similar specimens.

Forty-five bleaching molds were made by vacuum forming a polypropylene sheet (Buffalo Dental Manufacturing Co. Inc., Syosset, NY, USA) over equally spaced small metallic cylindrical weights (20 mm in diameter and 15 mm in height). Each mold was labeled and used to soak a specimen with the appropriate bleaching gel or the distilled water.

Baseline color of all specimens was recorded using a spectrophotometer (Color-Eye 7000, GretagMacbetch, New Windsor, NY, USA). Five specimens of each material (n = 5 was determined using error analysis with 0.05 level of significance) were placed in the molds that contained one of the following: 10% and 15% CP bleaching gel (Opalescence PF, Ultradent Inc., South Jordan, UT, USA) or distilled water (control). The specimens were kept in the medium for 8 h, removed, washed, and then kept in distilled water overnight. The procedure was repeated the next day. Color was recorded again after 3, 7, and 14 days. The data were collected and statistically analyzed using two-factor ANOVA test to compare the color stability of the tested materials.

**RESULTS**

Table 1 shows means and standard deviations of delta E* for the three solutions and the three materials.

Fisher’s PLSD intervals for comparisons of delta E* of the three materials and the three solutions at the 0.05 significance level were 1.0 and 1.0, respectively, as determined by the two-factor ANOVA [Table 2].

For specimens of Trim Plus provisional restorative material (the methacrylate-based material), delta E* of

| Material | Source | df | Sum of squares | Mean square | F | P | Power |
|----------|--------|----|---------------|-------------|---|---|-------|
| Material | Solution | 2 | 188.1 | 94.0 | 56.1 | <0.0001 | 1.000 |
| Solution | Interaction | 4 | 311.8 | 77.9 | 46.5 | <0.0001 | 1.000 |
| Residual | Total | 35 | 58.7 | 1.7 | | | |
specimens exposed to distilled water was statistically lower than values of delta E* of specimens exposed to 10% and 15% nightguard bleaching gel (NGBG). However, delta E* of Trim Plus exposed to 15% NGBG was statistically higher than delta E* of Trim Plus exposed to 10% NGBG.

For specimens of Luxatemp provisional material (the bis-acryl composite resin material), delta E* of specimens exposed to distilled water was statistically higher than values of delta E* of specimens exposed to 10% and 15% bleaching gel. There were no statistical differences in delta E* among specimens exposed to 10% and 15% bleaching gel.

Specimens of polycarbonate provisional crowns exposed to 15% bleaching gel showed a statistically lower value of delta E* than specimens exposed to 10% bleaching gel or to distilled water. There was no significant difference between specimens exposed to 10% bleaching gel or those exposed to distilled water.

When exposed to 10% NGBG, delta E* of Trim Plus was statistically higher than those of Luxatemp and polycarbonate crown material. Delta E* of Luxatemp exposed to 15% NGBG was significantly lower than polycarbonate crown material.

Exposure of the provisional materials to 15% NGBG showed that delta E* of Trim Plus was statistically higher than values of delta E* of Luxatemp and polycarbonate crown material. Delta E* of Luxatemp was statistically the same as delta E* of polycarbonate crown material.

Values of delta E* of specimens exposed to distilled water were significantly higher for Luxatemp and polycarbonate crown materials compared to the Trim Plus provisional material.

DISCUSSION

When used for extended periods, provisional acrylic prosthetic materials undergo discoloration in oral cavity after exposure to saliva or to staining solutions. These materials also exhibit yellowish or orange discoloration when exposed to vital tooth bleaching procedures. In the present study, the bis-acryl composite resin provisional restorative material did not change color when exposed to 10% or 15% vital bleaching gel. The acrylic methacrylate-based material exhibited high color changes and orange discoloration when exposed to 10% and 15% vital bleaching gel. This was in agreement with the findings of a study by Robinson and Haywood, where methacrylate-based provisional restorative materials turned orange when exposed to 10% CP bleaching solutions, and bis-acryl composite provisional restorative materials showed no color change. Previous studies have also reported that composite resins are color stable, whereas the acrylic-based materials show least color stability when exposed to vital tooth bleaching gel.

Thus, the acrylic-based provisional restorative materials should not be used where long periods of provisionalization are required.

The prefabricated polycarbonate crowns showed significant color resistance when exposed to 15% NGBG versus 10% NGBG or distilled water. This is in contrast to the results found by Robinson and Haywood where polycarbonate crowns did not change color at all when treated in distilled water.

When exposed to distilled water, the composite-based and polycarbonate crowns showed more color change than the methacrylate-based provisional material. This is in agreement with findings of Yuodelis and Faucher who reported that after 1 month's exposure to distilled water, methyl methacrylate was more color stable than bis-acryl-based composite materials.

CONCLUSIONS

Within the limitations of this study, when exposed to vital tooth bleaching gels, composite-based provisional restorative material showed the highest color stability followed by prefabricated polycarbonate crowns and methacrylate-based restorative material. In cases of prolonged use of the provisional restorations, especially in anterior regions, to prevent unacceptable orange discoloration and to avoid repeated fabrication of these temporary restorations, composite-based color stable provisional restorative materials should be used.

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Conflicts of interest

There are no conflicts of interest.

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