Impact Of Bleaching Agent On Marginal Integrity Of Various Aesthetic Restorative Materials- A Confocal Laser Scanning Microscope Study

Maneesha Das1*, Preethi Sathydevi2, Asha Reddy3, NarendraVarmaPenumatsa4, ShahadFahad Alsulaiman5, Debasish Mishra6

1*Associate Professor, Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha ‘O’ Anusandhan Deemed to be University, Bhubaneswar, Odisha, India. (Corresponding author) (drmaneeshadas1982@gmail.com)
2Senior Lecturer, Department of Conservative Dentistry and Endodontics, KMCT Dental College, Calicut, Kerala, India.
3Associate Professor, Department of Conservative Dentistry and Endodontics, Sri Balaji Dental College, Moinabad, Hyderabad, Telangana, India.
4Department of Preventive Dental Sciences, College of Dentistry, Prince Sattam Bin Abdul Aziz University, Alkharg, Kingdom of Saudi Arabia.
5Dental Intern, King Saud University, Riyadh, Kingdom of Saudi Arabia.
6Associate Professor, Department of Periodontics and Oral Implantology, Kalinga Institute of Dental Sciences, KIIT Deemed to be University, Bhubaneswar, Odisha, India.

ABSTRACT

Aim: Aim of the current research was to assess the effects of bleaching agents on the marginal integrity of different tooth-colored restorative materials.

Materials and Methods: 90 intact premolar teeth devoid of dental caries that underwent extraction in the process of orthodontic treatment having all their surfaces were considered in the research. 3×3×1.5 mm dimension class V cavity preparations were made employing the straight carbide bur. The 90 sample teeth were allocated to one of the following three groups (thirty in each): Group I: Microfilled composite resin, Group II: Microhybrid methacrylate-based composite, Group III: Nanohybrid Ormocer based composite. The specimens underwent thermocycling amid 5°C and 55°C (±2°C) for a five hundred cycles. The dwell duration was thirty seconds with a transfer period of ten seconds. The bleaching agent employed was 35% hydrogen peroxide with calcium. The samples thus coated were subjected to immersion in 1% methylene blue solution for twenty-four hours duration to permit dye diffusion into likely vacant gaps amid the tooth substance and restoration. The specimens thus subjected to sectioning were assessed to verify the degree of dye diffusion by means of Confocal Laser Scanning microscope.

Results: Microfilled composites exhibited the most microleakage (2.04± 0.09), in pursuit by Microhybrid methacrylate-based composites (1.39± 0.42), followed by Nanohybrid Ormocer based composite group (1.02± 0.12). These differences amid the different esthetic restorations were statistically significant. A significant mean difference was noted amid group I (Microfilled composite resin) as well as group III (Nanohybrid Ormocer based composite).

Conclusion: Within the limitation, the present study concluded that the significant reduction in microleakage was seen in Nanohybrid Ormocer based composite group followed by Microhybrid methacrylate-based composite group and Microfilled composite resin group after bleaching procedure.

Keywords: Bleaching agent, class V cavities, microleakage, restorative material

I. INTRODUCTION

One of the key factors in attaining appropriate aesthetic appearance of teeth is the tooth color that can be enhanced by various techniques/processes including bleaching. Bleaching involves whitening or eliminating the tooth color by applying chemical materials that cause oxidation of the organic pigments in teeth. In the process of ‘vital-bleaching’, multiple agents and methods can be employed. The frequent materials that can be utilized for either in the clinic (‘in-office’) or ‘at home’ bleaching are hydrogen peroxide and carbamide peroxide.1
Once the application of a bleaching agent is accomplished onto the surface of teeth, it infiltrates through the enamel layer, into the interprismatic areas and then the dentin via dentinal tubules. Both hydrogen peroxide and carbamide peroxide exhibit actions by composite oxidative processes, and releases oxygen having very less molecular weight. The oxygen thus released causes a chemical degradation of the chromogens which are rendered soluble with expulsion via diffusion. This causes teeth to get rid of pigments with subsequent lightness in color.

Thus, the effectiveness of bleaching materials upon dental restorative agents has been appraised lately. Higher demand for esthetic techniques has led to the introduction of an array of tooth-colored restorative supplies. One amongst them is the composite restorative agents which are tooth-colored. Advancements in material-science have led to the production of dissimilar composite agents with incorporation of alterations that have further enhanced their esthetic appearance. These tooth-colored restorative agents may be present on the teeth that require bleaching.

The pertinent literature depicts that materials employed in bleaching can causes higher surface roughness of resin composites with reduction in the micro-hardness of both the tooth and composite. The success of any kind of restoration depends on the microleakage which poses a great challenge. Literature shows inadequate data on effects of materials used in bleaching on tooth-colored restorations. Hence, the current research was carried out to assess the effects of bleaching materials upon the marginal integrity of different tooth-colored restorative materials.

II. MATERIALS AND METHODS:

Ninety intact premolar teeth devoid of dental caries that had undergone extraction as a part of orthodontic treatment having maintained integrity of all the surfaces were considered in the study. Teeth with visible cracks, areas of hypoplasia, WSL’s as well as dental caries were excluded from the study. A vigorous ultrasonic prophylaxis of the sample teeth was performed. Subsequently, using a rubber cup and paste for oral prophylaxis, the sample teeth were subjected to polishing. After this the sample premolars were sterilized and immersed in 1% thymol solution until additional preparation.

Preparation of samples:

Using a straight carbide bur, class V cavity preparation of size 3×3×1.5 mm was done on the buccal surface CEJ of each sample tooth. Thus, ninety class V cavity preparations were performed on the premolar teeth in total. These 90 premolar teeth were allocated at random to one of the following three groups (i.e. thirty specimens in each) as per the composite materials employed:

Group I: Microfilled composite resin:

Microfilled composite resin was incrementally introduced with Teflon coated equipment within the cavity preparations and subjected to light-curing for thirty seconds. Sof-Lex discs were used for the cavity finish and polish.

Group II: Microhybrid methacrylate-based composite:

First a layer of the bonding agent was coated on the sample teeth followed by light curing. After this, the Microhybrid methacrylate-based composite was used to restore the cavities that were prepared on the sample teeth. Sof-Lex discs were finally used for the cavity finish and polish.

Group III: NanohybridOrmocer-based composite:

NanohybridOrmocerbased composite was incrementally introduced with Teflon coated equipment (GDC) within the cavity preparations and subjected to light-curing for thirty seconds. Sof-Lex discs were used for the cavity finish and polish.

Each and every sample was subjected to coating using dual coat of nail polish above 2 millimeters from the restoration margins prior to application of the bleaching agent. The samples were then subjected to immersion in distilled water.

Thermocycling:
The specimens underwent thermocycling amid 5°C and 55°C (±2°C) for a five hundred cycles. The dwell duration was thirty seconds with a transfer period of ten seconds. The sample teeth were subjected to storage in distilled water and positioned at 37°C in an incubator for twenty-four hours.

**Bleaching procedure:**

The bleaching agent that was employed was 35% hydrogen peroxide with calcium. The samples were cleansed, and a homogenous gel was prepared by means of 2 syringes connected to each other and pushing the plungers four times per side. One syringe containing the homogenous mixture thus prepared was used to apply a 0.5 to 1 millimeter thick coat on the tooth surface, leaving it in place for forty minutes. In an attempt to facilitate the release of oxygen bubbles produced coupled with renewal of the gel contact with sample surface, once in every five to ten minutes, a disposable micro applicator was passed over the tooth. At the completion of this therapy, the specimens were subjected to washing with distilled water.

**Dye penetration and evaluation of microleakage:**

Following the process of thermocycling, the teeth-surface excluding the restorative material, 1.5 millimeters from the margins, were subjected to application with a dual layer of nail varnish. The samples thus coated were subjected to immersion in 1% methylene blue solution for twenty-four hours duration to permit dye diffusion into likely vacant gaps amid the tooth substance and restoration. Subsequent to dye contact, the samples were subjected to washing and rinsing with distilled water.

**Confocal laser scanning microscope observation:**

The specimens thus segmented were assessed for the degree of dye diffusion employing Confocal Laser Scanning microscope as well as oil immersion objectives in combination with a green filter (wavelength 546 mm) down the tooth/restoration interface and the deepness of dye diffusion was counted as under:
- Score 0 = Absence of dye diffusion
- Score 1 = Dye diffusion through ½ the occlusal/gingival wall
- Score 2 = Dye diffusion through > ½ the occlusal/gingival wall
- Score 3 = Dye diffusion across the axial wall

**Statistical Analysis:**

The data thus gathered was subjected to analysis with Statistical Package for Social Sciences (SPSS), version 20 (SPSS Inc. Chicago, IL, USA). The marginal integrity was assessed statistically for every restorative group subsequent to the bleaching process. ANOVA test pursued by Tukeys post hoc study was employed for statistical analysis to ascertain the significance of the disparities amid the groups. The statistical significance was set at a p value of less than 0.05.

### III. RESULTS:

Table 1 depicts scores of mean microleakage for the different tooth-colored restorative materials following the process of bleaching. Microfilled composites exhibited the most microleakage (2.04±0.09), in pursuit by Microhybrid methacrylate-based composites (1.39±0.42), followed by NanohybridOrmocer-based composite group (1.02±0.12).

<table>
<thead>
<tr>
<th>Esthetic restorative materials</th>
<th>Mean±SD</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I: Microfilled composite resin</td>
<td>2.04±0.09</td>
<td>0.1124</td>
</tr>
<tr>
<td>Group II: Microhybrid methacrylate-based composite</td>
<td>1.39±0.42</td>
<td>0.0262</td>
</tr>
<tr>
<td>Group III: NanohybridOrmocer-based composite</td>
<td>1.02±0.12</td>
<td>0.0216</td>
</tr>
</tbody>
</table>

Table 2 shows the comparative assessment of mean microleakage scores for the different tooth-colored restorative materials following the process of bleaching. The lowest microleakage was depicted by the NanohybridOrmocer-based composites (1.02±0.12) while the most was present in the Microfilled composite resin group (2.04±0.09). These differences amid the dissimilar esthetic restorations were statistically significant.

<table>
<thead>
<tr>
<th>Esthetic restorative materials</th>
<th>Mean±SD</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I: Microfilled composite resin</td>
<td>2.04±0.09</td>
<td>0.1124</td>
</tr>
<tr>
<td>Group II: Microhybrid methacrylate-based composite</td>
<td>1.39±0.42</td>
<td>0.0262</td>
</tr>
<tr>
<td>Group III: NanohybridOrmocer-based composite</td>
<td>1.02±0.12</td>
<td>0.0216</td>
</tr>
</tbody>
</table>

Table 2: Comparison of mean microleakage values of various esthetic restorative materials after bleaching.

www.turkjphysiotherrehabil.org
Manifold comparative assessments of mean microleakage scores of all the tooth-colored restorative agents employing Tukey's post hoc test is delineated in table 3. 1.02 was the mean difference amid Microfilled composite resin - Group I and the Nanohybrid Ormocer-based composite – Group III. The differences amongst these groups were statistically significant.

Table 3: Multiple comparisons of mean microleakage values of various esthetic restorative materials using Tukey's post hoc test

<table>
<thead>
<tr>
<th>Groups</th>
<th>Compared with</th>
<th>Mean Difference</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I: Microfilled composite resin</td>
<td>Group II</td>
<td>0.65</td>
<td>0.167</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>1.02</td>
<td>0.001</td>
</tr>
<tr>
<td>Group II: Microhybrid methacrylate-based composite</td>
<td>Group I</td>
<td>-0.65</td>
<td>0.167</td>
</tr>
<tr>
<td></td>
<td>Group III</td>
<td>0.37</td>
<td>0.072</td>
</tr>
<tr>
<td>Group III: Nanohybrid Ormocer-based composite</td>
<td>Group I</td>
<td>-1.02</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Group II</td>
<td>-0.37</td>
<td>0.072</td>
</tr>
</tbody>
</table>

IV. DISCUSSION:

True or apparent discoloration of anterior is among the key causes for patient’s seeking esthetically fulfilling dental therapy. Restorations employed in dental treatment need to be enduringly durable for surviving in the mouth. Of late bleaching has evolved as an admired therapy for eradicating surface staining and restoration of esthetics. Multiple bleaching materials have been employed in dentistry which includes hydrogen peroxide that is documented as one among the most superior bleaching agents. Thus, the dentist must be mindful of the effects of such agents upon the surface of teeth and restorations. Microleakage could stem from the fact that chemical sequel from bleaching of teeth can alter the physical as well as mechanical characteristics of dental hard tissues and composite restorations.

Stresses released within the restorative material as well as its margins in process of polymerization shrinkage can cause microleakage and resultant gaps at the restoration and tooth edge, if they surpass the bond strength. Pattern of the cavity/C-factor (that is the ration between bonded and unbounded surface area), cavity dimensions, filling methodology of composites into the prepared cavity, mechanical characteristics of the composites are among some parameters that affect polymerization stresses. In the present research, efforts were made to maintain all these variables at the same level for the 3 groups. To maintain C-factor at identical levels, all the class V cavity preparations were made uniform with analogous sizes along with shapes. Thermal alterations that occur in the oral cavity were simulated by thermocycling in this research to assess the efficacy of bleaching on dental restorative materials in the oral cavity as well as unnaturally age the samples. Therefore in this research, thermocycling was performed for five-hundred cycles amid 5°C and 55°C (±2°C), with dwell duration of thirty seconds and a transfer period of ten seconds. This is in accordance with the research of Rashwan Ahmed T et al. where five hundred cycles of thermocycling were used to replicate temperature inside the oral cavity.

In this research, the lowest microleakage was noted in Nanohybrid Ormocer-based composites, in pursuit by Microhybrid methacrylate-based composites and Microfilled composites in that order. These results are in disagreement with the research of Hooshmand T et al. who said that ormocer-based hybrid composites caused the greatest mean microleakage scores without significant differences amid the groups. It may be arguable that the adhesive structure might have an effect on the marginal leakage of resin containing restorations. An additional research by Bedran de Castro et al. stated that the ormocer substance exhibited appreciably superior scores of microleakage. Research by Sartori et al. illustrated that 35% hydrogen peroxide showed nil effect on microleakage of Filtek Z250, a microhybrid composite that was subjected to test at the adhesive edge within enamel/dentin. Hashemikamangar et al. in addition established no significant variations in microleakage amongst the control as well as bleached groups of the methacrylate-supported composites (Filtek Z250) that were put to test employing thirty percent hydrogen peroxide.
Research conducted by Ulukapi et al.\textsuperscript{13}, Jacob and Kumar\textsuperscript{14} and Moosavi et al.\textsuperscript{15} concluded that bleaching is an efficient parameter influencing the sealing capacity of restorative materials, as microleakage enhanced following employment of dissimilar hydrogen peroxide concentrations. The preceding research that had been conducted, implicated that enhanced microleakage of restorative agents following bleaching is attributed to persistence of remaining peroxides arisen from the bleaching agents that enhances microleakage because of interference with resin connection to the tooth.

The current research delineated that hydrogen peroxide can cause effects on the organic/inorganic constituents in dentin, thereby leading to protein denaturation. Such alterations in the morphology can decrease the activity of resin based restorative agents.\textsuperscript{16} Berger et al.\textsuperscript{17} inferred that dissimilar concentrations of hydrogen peroxide diffusion take place owing to its small molecular weight and capacity to cause protein denaturation, which enhances the motion of ions in the course of the dental hard tissues coupled with polymerization shrinkage that probably alters the adhesive boundary of enamel and restorative materials.

In vitro research thus present valuable information on the performance of substances, under restricted experimental circumstances, which are not easy to attain clinically. This research has certain limitations such as excluding few confounding parameters like presence of saliva in the mouth that could affect the study results. Thus, further research assessing the effects of such parameters on the marginal integrity of resin-based restorative materials need to be conducted. The efficient application of this mixture in a variety of added concentrations as well mandates study. Long duration clinical research is necessary to strengthen and authenticate the outcomes of this in vitro research.

V. CONCLUSION:

Within the limitation, the present study concluded that the significant reduction in microleakage was seen in Nanohybrid Ormocer-based composite group followed by Microhybrid methacrylate-based composite group and Microfilled composite resin group after bleaching procedure.

REFERENCES: