Spectrophotometric analysis of color stability of esthetic restorative material in chlorhexidine mouthwash: An in vitro study

Iqbal Singh, S Sai Kalyan1, Rakesh Kumar Gupta2, Parveen Lone3, Sagolsem Chandarani4

Departments of Public Health Dentistry, 2Department of Pedodontics and Preventive Dentistry Principal Indira Gandhi Government Dental College and 3Oral Surgery, Indira Gandhi Government Dental College, Jammu, Jammu and Kashmir, 2Department of Conservative Dentistry and Endodontics, Terna Dental College, Mumbai, Maharashtra, 3Department of Conservative Dentistry and Endodontics, Dental College, Regional Institute of Medical Sciences, Imphal, Manipur

Abstract

Background: Commendable aesthetic properties of composites make it a pioneer filling material. However, discoloration of composite resin materials emerges as a major clinical problem in a long term.

Aims and Objectives: Aim of the study is to evaluate the color stability of nano filled and micro hybrid dental composite resin in chlorhexidine mouthwash

Materials and Methods: 20 specimens of dimension 10*2mm were prepared of A2 shade. All the prepared samples were immersed in 20 ml of distilled water in separate containers according to the group. Further incubation at 37°C for 24 h was done. After 24 h, baseline color values of each sample were recorded using a spectrophotometer. After recording the baseline color measurements, 10 specimens (random selection) from each group were placed in 20 ml of 0.2% chlorhexidine mouthwash for 24 h duration. The L*a*b* system of the Commission Internationale de l’Eclairage (CIE L*a*b* Color Scale) was used for the determination of colorimetric values of the specimens.

Results: The color change was displayed by both the samples after immersion in the mouthwash but the change was not statistically significant (0.763). ΔE value for nano filled composites is 3.25 while for the micro-hybrid composites the value is 3.56.

Conclusion: The colorimetric values of nano filled composite resins are more stable than the micro hybrid composite due to exposure to chlorhexidine mouthwash.

Keywords: Chlorhexidine mouthwash; color stability; composite resin; spectrophotometer

INTRODUCTION

Composites have achieved a pioneer position among the filling materials that are employed in direct restorative techniques. Its commendable esthetic properties make it a choice for various therapeutic indications. The composite must be clinically chosen on the fact that whether the requirement is mechanical or esthetic. The material with more filler volume will be selected if mechanical considerations are of prime concern. On the other hand, if esthetic considerations are important, the particle size is taken into consideration.1-3

Over an extended period, discoloration of composite resin materials emerges as a major clinical problem. Various extrinsic and intrinsic factors affect the color stability of

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Dental esthetics has been of utmost importance to patients, and therefore, primary emphasis is made on maintaining perfect color stability between teeth and restoration in the long term. Thus, the present study aims at observing the effect of nonalcoholic mouthwash on the color stability of nanofilled and microhybrid dental composite resins.

**MATERIAL AND METHODS**

This *in vitro* study was conducted in Indira Gandhi Dental College, Jammu, Jammu, and Kashmir, India. Materials used in this study are listed in Tables 1 and 2.

**Specimen preparation**

Using a composite filling instrument (Dentsply Composite Filling Instrument), 20 specimens (10 specimens for each group) were prepared. The dimension of the specimen was kept to be 10 mm × 2 mm of A2 shade. It was prepared with the help of stainless steel mold. The composite was polymerized both from the top and the bottom for 20 s as mentioned by the manufacturer’s instructions using a LED light-curing unit (Bee cool Turbo II).

The specimens were divided into two groups (*n* = 10).
- Group I – A nanofilled composite; (PREVEST DenPro, Jammu, India)
- Group II – A microhybrid composite; (PREVEST DenPro, Jammu, India).

All the prepared samples were immersed in 20 ml of distilled water in separate containers according to the group. Further incubation at 37°C for 24 h was done. After 24 h, baseline color values of each sample were recorded using a spectrophotometer (T 70 PG instrument, Alma Park, Leicestershire, United Kingdom). The L*a*b* system of the Commission Internationale de l’Eclairage (CIE L*a*b* Color Scale) was used for the determination of colorimetric values of the specimens.

After recording the baseline color measurements, 10 specimens (random selection) from each group were placed in 20 ml of 0.2% chlorhexidine mouthwash (Rexidin Plus, Aurangabad, India) for 24-h duration. After 24 h, the specimens were washed with distilled water followed by blot-drying, and then, it is subjected to spectrophotometric analysis. Following this, the values after the immersion were recorded for each sample. The measurement of the discoloration of the composite was analyzed. The color differences in this system are calculated by the following formula:

\[ \Delta E'_{ab} = (|\Delta L'|^2 + |\Delta a'|^2 + |\Delta b'|^2)^{1/2} \]

Spectrophotometry works on the principle that every substance absorbs or transmits certain wavelengths of radiant energy. It does not absorb or transmit other wavelengths.
The light absorption peak of the material is measured for the analysis. The wavelength of the measurement spectrum used in this study was between 400 and 720 nm.[9]

**Statistical analysis**

Data were collected and entered into MS Excel spreadsheet 2010. Statistical analysis was done usually by Statistical Package for the Social Sciences (SPSS) software version IBM 22, and data were expressed in frequency and mean value. The comparison between the two groups was done using a student t-test. Statistical significance was taken to <0.05.

**RESULTS**

Table 3 denotes the before and postimmersion measurements of the two groups, i.e., nanofilled composite and microhybrid composite. The mean colorimetric value, i.e., L*a*b*, is shown in Table 4.

Table 4 denotes a comparison of color change between nanofilled composite and microhybrid composite. The comparison was done with a t-test, and it showed there is no statistically significant difference between the group (P = 0.763).

**Interpretation**

The color change was displayed by both the samples after immersion in the mouthwash, but the change was not statistically significant (0.763). ∆E value for nanofilled composites is 3.25, while for the microhybrid composites, the value is 3.56.

**DISCUSSION**

The discoloration is one of the main grounds for the replacement of esthetic restorative material, i.e., resin composite. They are manifested by various food materials and beverages in the oral cavity. Furthermore, subjection to the mouth rinse leads to staining of the tooth and tooth-colored restorative material. Other contributing factors which affect the differences observed in color stability are the type of composite resin and mouthwash formulation.[10] Mouthwashes contain various chemicals in their composition that can cause decomposition and softening of the surface of restorative materials. These ingredients include alcohol, detergent, emulsifier, and organic acids.[11]

Chlorhexidine is a broad-spectrum antimicrobial mouthwash. The chlorhexidine mouthwash containing 0.2% chlorhexidine should be used at 10 ml volume per rinse. It delivers 20 mg of the total dose of chlorhexidine. If the concentration of chlorhexidine is lower, it minimizes its side effects while still maintaining its benefits.[7] However, brown discoloration of the teeth, restorative materials, and the tongue are the pre-eminent side effect of chlorhexidine.[7,12] Renewal of approximately 30%-40% of composite resin restorations takes place as a result of discoloration within a period of 5 years.[11] Composite, when immersed in chlorhexidine mouthrinse for 24 h, is equivalent to 2 min of use daily for 2 years.[3]

Staining can be evaluated by visual and/or instrumental techniques. One of these instrumental techniques is spectrophotometry. It is superior to visual evaluation as it leaves no room for subjective interpretation.[13,14] Spectrophotometer is an instrument for physical analysis. No human elucidation is made while wavelength-by-wavelength spectral analysis of the reflecting and/or transmitting properties of objects is provided.[15]

The CIE L° a°b° system represents a 3D color space having components of lightness (L°), red-green (a°), and yellow-blue (b°). A significant aspect of the CIE L° a°b° system is that color differences between specimens can be given as a single parameter ∆E.[16] It is a suitable method for small color change determination. It has several advantages such as repeatability, sensitivity, and objectivity.[17] It has been stated that ∆E value ranging from 1 to 3 is discernible with naked eyes. Whereas any value greater than 3.3 is clinically unacceptable.[17]

In the present study, the color change for nanofilled composite was lesser (∆E 3.25) as compared to the color change for microhybrid composites (∆E 3.56), but the colorimetric variations for both composite resins were statistically nonsignificant (0.763). The color change in nanofilled is not visually detectable. The change in microhybrid was clinically unacceptable. Similar results were observed by Shree Roja et al.[3] and Ulusoy et al.[11] in their studies in which nanofilled composite showed higher
color stability. Similarly, an in vitro study performed by Ghiorghe et al.[16] in 2013 also observed that nanofilled is more stable comparing with microhybrid regarding color changes. This is in line with the result shown by other investigators who showed that microhybrid composites show major discoloration when subjected to various agents.[19-21]

The abovementioned result can be accredited to the filler content. Combining nanoinparticle increases the filler volume of composite resin up to 79.5%. Lower dimension and area distribution of filler particles lead to an increase in filler loading. A decrease in polymerization shrinkage while an increase in the mechanical properties is the advantage of increasing filler loading to composite resins.[22,23] When composite resins with different filler particle sizes were compared, higher Δ values were obtained for hybrid composite resins compared to other types of composite resins.[24]

Excessive water sorption may decrease the life of a resin composite. This happens by expanding and plasticizing the resin component. It hydrolyzes the silane and further causes microcrack formation between the filler and matrix. Stain penetrate in the microcracks or interfacial gaps formed, thus causing discoloration. Various studies state that more amount of water with staining solution is absorbed by hydrophilic materials as compared to hydrophobic materials. Therefore, hydrophilic materials have fairly higher discoloration as compared to hydrophobic materials.[5,11,25]

The observed color changes, i.e., ΔE, could be discrete and lesser manifested in vivo. Comparatively, in vivo, a greater amount of time is required to stain to cause a clinically perceptible color change in the composites. Credit for this slow-paced appearance of staining can be given to the cleansing action of saliva in the oral activity. The daily rinsing and brushing action for oral hygiene maintenance also contributes to the extension in the staining period.[18]

CONCLUSION

The present study concludes that the colorimetric values of nanofilled composite resins are more stable than the microhybrid composite due to exposure to chlorhexidine mouthwash.

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Conflicts of interest
There are no conflicts of interest.

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