Different Curing Modes and its Effect on Colour Stability of Universal Submicron Hybrid Composite using Spectrophotometer: An Invitro Study

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Abstract - *Due to patient's demand for esthetic appearances, composite resin restorations currently occupies a significant portion of dentist's routine practice. It is very important that the esthetic characteristics of the material be able to mimic the natural tissue. It is known that dental composites are susceptible to discolouration because of several factors such as water hydrolysis, UV light exposures and staining substance. It is important to consider that the different irradiation procedures will lead to different structures of the resulting polymer. Thus, the purpose of this study is to compare and evaluate the effect of different curing modes of LED curing light on submicron hybrid composite resin and its relation to colour stability.* ***Aim:*** *To evaluate and compare the effect of different curing modes of LED curing light on submicron hybrid composite resin and its relation to colour stability.* ***Methods and Material:*** *Universal submicron hybrid composite, Brilliant Everglow (Coltene) was cured using Light-emitting diode operated into two different curing modes: continuous and intermittent. Forty specimens of composite disc with 3mm diameter and 1.5mm thickness were divided into two groups of 20 samples each. Group1: Continuous 40s: 480 mW/cm^2. Group2: intermittent 30s: 480 mW/cm^2 for 10s followed by 5s rest. These polymerised samples were immersed in methylene blue dye for 24 hours and later washed and immersed in absolute alcohol for 24 hours. The colour released into absolute alcohol was assessed by spectrophotometer.* ***Statistical Analysis:*** *Results were analysed for spectrophotometer values using the Wilcoxon rank sum test.* ***Results:*** *The group cured with intermittent curing mode stained less compared to the group cured with a continuous curing mode.* ***Conclusion:*** *Irradiation time plays a crucial role in staining of the polymerized light cured resin. The specimens cured using intermittent curing mode had a lesser dye absorption, signifying the role of curing modes on the physical properties of composite resins like colour stability.*

Key Words: irradiation time, light intensity, spectrophotometry, staining.

1. INTRODUCTION

Composite resin restorations have begun to constitute a significant portion of dentist's routine practice due to the patient's increasing demand for an esthetic appearance. Currently available dental composites provide satisfactory strength and high esthetic appearance. Proper colour match of a composite restoration with the adjacent teeth is important not only at the initial stage of the restoration, but also over a longer period of time.

However, despite the recent developments, colour stability of light cured composites after long term intraoral exposure remains a concern. The clinical performance of composite resins is directly related to the degree of monomer conversion after photo-polymerization.[1]

The parameters that influence the degree of polymerization of composite resins: composition, shade and translucency, characteristics of the light-curing unit used, rate of curing, distance between light-curing tip and restoration surface, duration of photo-polymerization.[2,3]

Photo-polymerization is of fundamental importance for optimization of the physical and mechanical properties and clinical results of composite material.[4] Thus, the percentage of remaining double bonds (C=C) is considered a fundamental parameter influencing a variety of mechanical, chemical and biological properties.[5] Despite significant developments in improving the optical properties of resin composite materials, their colour stability remains a challenge.

Thus, the purpose of the study was to evaluate and compare the effect of different curing modes of LED curing light on submicron hybrid composite resin and its relation to colour stability.

1.1 MATERIALS AND METHOD

The research protocol designed was ethically approved by the Institutional Ethical Committee.

40 specimens of composite resin disc (Brilliant Everglow A2/B2 shade, Coltene) with 3 mm diameter and 1.5 mm thickness were prepared by using spherical Teflon moulds. The samples were divided into two groups of 20 samples each.

These resin composites were cured with LED curing units by continuous and intermitttent mode. The LED light cure unit used is Bluephase N MC (Ivoclar Vivadent).

Group 1: Brilliant Everglow A2/B2 shade (Coltene) cured for 40s at continuous light curing mode at 480 mW/cm^2.

Group 2: Brilliant Everglow A2/B2 shade (Coltene) cured for 30s at Intermittent light curing mode at 480 mW/cm^2 for 30 seconds (10 sec curing followed by 5 sec rest).

After polymerization, the composite resin samples were removed from the moulds, placed in an empty test tube and each specimen was placed in an incubator (37 ± 2°C) for 24 hours. Later, they were individually immersed in 1 ml of 2 % methylene blue solution and placed at 37 ± 2°C. After 24 hours, the specimens were rinsed under running distilled water for 1 minute and stored at 37 ± 2°C at relative humidity for 24 hours. The specimens were immersed in new test tubes containing 1 ml of absolute alcohol for 24 hours. The solutions were filtered and centrifuged for 3 minutes at 4000 revolutions per minute, and the supernatant was used to determine dye absorbance in a spectrophotometer.

1.2 STATISTICAL ANALYSIS

Data were analyzed statistically for spectrophotometer using the SPSS 12 Software. The Wilcoxon rank sum test was used for the end absorbance changes between the groups. *P*-value less than 0.05 was considered as a significant level.

1.3 RESULTS

Higher mean absorption was recorded in Group 1 (continuous curing mode) as compared to Group 2 (intermittent curing mode). The maximum absorption using the continuous curing mode was found to be 0.033 while in the intermittent mode is was 0.009. The difference in the mean absorption among the groups was found to be statistically significant. Descriptive analysis for absorption of two methods have been described in table 1.

The difference in the median values of two methods was statistically highly significant between groups 1 and 2 with p-value < 0.0001.

The graphical representation of the data for two methods along with error bars is shown in chart 1.

Table -1: Descriptive analysis for absorption of two methods.

Methods	Absorption				
	Mean	SD	Median	Minimum	Maximum
Continuous	0.025	0.006	0.025	0.016	0.033
Intermittent	0.006	0.002	0.006	0.003	0.009
P-value*	< 0.0001 (S)				

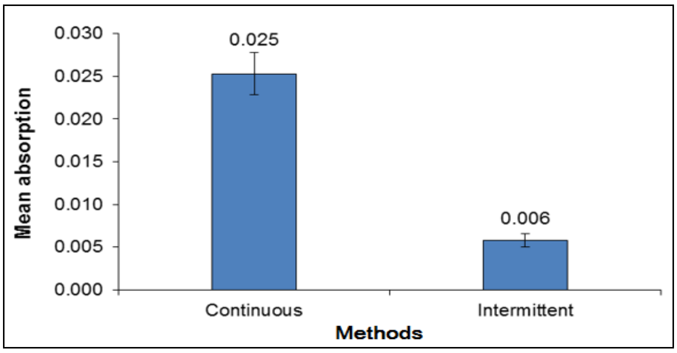

Chart -1: Mean absorption of two methods along with error bars.

2. DISCUSSION

Composite resins have been introduced into the field of conservative dentistry to minimize the drawbacks of the acrylic resins and silicate cements in the 1940s. These early, chemically cured composite resins required base paste to be mixed with the catalyst, leading to problems with the proportions, mixing process and colour stability. Since 1970, composite materials polymerized by electromagnetic radiation appeared.

The irradiance of the light source, the exposure time and light transmission of composite resins are significant variable that affect the hardness or conversion profile of the material. Also, its properties depend on the degree of conversion of monomer. A high degree of conversion not only gives hardness and strength to the material,[6] but also colour stability.[7] Thus, a reduction in remaining double bonds to the lowest possible level is normally considered a desirable feature of a polymerization system. Incomplete cure of the material leads to lower mechanical properties and wear performance; leakage residual monomer and colour stability decline as well.[8]

Different factors influence staining of resin based materials. Staining susceptibility of composite resins might be attributed to their degree of water sorption and hydrophilicity of matrix resin, that is, if the resin composite can absorb water it can also absorb other fluids like Methylene blue dye.[9] The glass filler particles will not absorb water into the bulk of the material; however, can adsorb water onto the surface. The life of the resin composite may decrease due to excess of water sorption. This may lead to expansion of the resin component and leading to micro-crack formation. Therefore, the interfacial gaps between the filler and matrix allow penetration of stains and discolorations. The present study measures the dye penetration and indirectly reflects the amount of conversion of the double bonds as it is given that composites containing more than 35% of unconverted C=C bonds are susceptible to discoloration.[10]

In the present study methylene blue was used, as this dye dissolves as monomer and dimer in aqueous environment and is readily taken up by the composite discs by sorption phenomenon.[11]

To prevent the bias, mylar strips on the surface of the discs was used to obtain a smooth surface finishing.

For analyzing the dye absorbance, the discs were placed in methylene blue and then in absolute alcohol by which there was a release of methylene blue absorbed by the composite discs into the alcohol.[12] Alcohol uptake of the dye may be due to the hydroxide groups that are suitable for cationic dye removal like methylene blue.[13]

Since instrument measurements eliminate the subjective interpretation of visual-colour comparison, spectrophotometers have been used to measure colour changes in dental materials. Spectrophotometer works on the basis of Beer-Lambert's law, which states that the absorption of light transmitted through a medium is directly proportional to the concentration of the medium. Spectrophotometer is an instrument for physical analysis, and provides wavelength-by-wavelength spectral analysis of the reflecting and/ or transmitting properties of objects without interpretation by human.[14]

The degree of conversion of a given resin composite is influenced by the energy density.[15] Insufficient energy density results in less than maximal coversion,[5] and the demonstrated differences in quantity of remaining C=C are reflected in other polymerization characteristics.

Energy density (J/cm^2) is equal to the product of light intensity and the irradiation time.[5] The peak wavelength among light curing units varies from about 450-490 nm, and the irradiance ranges from 400-800mW/cm^2. A 2mm thick resin composite restoration requires a radiant exposure of 8 J/cm^2 (400mW/cm^2 x20s=8000mWs/cm^2).[12] In the present study keeping the light intensity constant, it was observed that the energy density decreased for the samples cured with continuous mode for 40s.

3. CONCLUSION

The role of different curing modes of LED on the colour stability of the composite resins was determined. The specimens cured using continuous curing mode had a higher dye absorption, signifying the role of curing modes on the physical properties of composite resins like colour stability.

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