How to Cite:
Mann, N. S., Goel, G., Kaushik, P., Jhamb, A., Rana, M., & Batra, D. (2022). Efficacy comparison of various oxygen lnhibition layer (OIL) minimizing agents on composite resin by analysis of two different physical properties: An in vitro study. *International Journal of Health Sciences*, *6*(S1), 866-871. https://doi.org/10.53730/ijhs.v6nS1.4835

Efficacy Comparison of Various Oxygen Lnhibition Layer (OIL) Minimizing Agents on Composite Resin by Analysis of Two Different Physical Properties: An in Vitro Study

Navjot Singh Mann
Department of Conservative Dentistry and Endodontics, National Dental College & Hospital, Derbassi, India

Garima Goel
MDS Endodontist, Asya Dental & Aesthetic Clinic, Mohali, India

Piyush Kaushik
MDS Endodontist, Asya Dental & Aesthetic Clinic, Mohali, India

Ashu Jhamb
Department of Conservative Dentistry and Endodontics, National Dental College and Hospital, Derbassi, India

Manu Rana
Department of Conservative Dentistry and Endodontics, National Dental College and Hospital, Derabassi, India

Divya Batra
Department of Conservative Dentistry and Endodontics, National Dental College and Hospital Derabassi, India

***Abstract*---**Introduction: Composite resins are the most common restorative materials that are used these days and have been radically improving over the past few years. Their polymerisation reaction can be inhibited during light-curing due to the oxygen presence in atmosphere. Aim/objective: The aim of this study is to evaluate effect of different air inhibition coating strategies on composite resin material in terms of hardness and discolouration. Material and Methodology: Composite discs of 6.5 X 2mm were prepared for samples which were cured under a) 0.5mm thick mylar strip b) thin layer of glycerine c) layer of KY jelly (commercial lubricant) d) air cure. These samples were dipped in cola, turmeric milk, coffee and distilled

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
***Corresponding author**: Goel, G.; Email: garimagoel3194@gmail.com*
Manuscript submitted: 27 Nov 2021, Manuscript revised: 18 Feb 2022, Accepted for publication: 09 March 2022

water for 14 days. Spectrophotometric analysis was done to assess the colour change and Vicker's hardness test for assessment of the hardness. Statistical analysis was done and the results were concluded. Results: The results were analyzed with ANOVA one-way test followed by Student Newman-Keul test. Moreover, multiple comparisons of means were performed using the Student t-test ($p<0.05$). Conclusion: Presence of Oxygen inhibition layer (OIL) on surface layer of composite affected the specimens adversely by reducing the microhardness and increasing instability of colour.

***Keywords*---**composite, glycerine, K-Y Jelly®, microhardness, mylar matrix, oxygen inhibition layer (OIL), spectrophotometry.

Introduction

Composite resins these days are the first material that pops in the head of clinicians whenever a restoration is required in the oral cavity. Bowen first reported a monomer named bisphenol-A diglycidyl methacrylate (bis-GMA) and the fruitful blend of composite by including inorganic fillers (Garoushi et al., 2007). Composite resins have the advantage of being clinician as well as patient friendly material. However, a concerning drawback of this material lies in its ability to discolour in presence of food and drink and decrease in hardness over time. This has been attributed to the presence of oxygen inhibition layer (OIL) on the last cured layer of resin due to it's polymerisation reaction with atmospheric oxygen. This layer is although beneficial in the intermediate increments for bonding, is said to negatively affect the restoration if present on outer surface.2 *Mylar strip and glycerin can act as physical barriers once placed on the surface of the resin before the light-curing procedures to prevent it's formation (Garoushi et al., 2013). Another material that is famous amongst practitioners nowadays is the K-Y Jelly®, a commercial lubricant. However, there is no study that has tested the effect of this material on this aspect.

Therefore, this study aims to comparatively test the effect of these agents on discolouration and hardness of composite resin. A suitable method to test the discolouration is Spectrophotometer and for Hardness testing is the Vicker's microhardness test. The null hypothesis taken was that a) there is no difference in hardness when three of the OIL inhibiting agents are used before final cure of resin b) there is no difference in colour stability of materials when the OIL inhibiting agents are used and specimens immersed in different immersion beverages.

Materials and Method

A total of 80 composite resin discs were prepared of dimension 6.5mm x 2mm using a Teflon mould. Nanohybrid composite resin (Filtek Z250) was used with an initial shade A1. Light-curing was performed using a light emitting diode (LED) (Coltolux, Coltene Whaledent) according to the manufacturer's instructions (20 sec), with the light at 1 mm of distance and perpendicular to the surface of the specimens. The specimens were divide into 4 main groups.

- Group A: Specimens polymerised after placing a 0.05mm thick mylar strip
- Group B: Specimens polymerised after placing a thin layer of glycerine over the composite specimen. After polymeristaion glycerine was removed using ethanol.
- Group C: Specimens polymerised after placing a uniform layer of K-YJelly®. After curing the jelly was removed using a spray of water as it is water soluble.
- Group D: specimens cured in open air. This was the control group.

Hardness testing: Vicker's (Microhardness Tester MHT4, Zeiss, Jana, Germany) microhardness testing was done under 200g load. Mean value of three indentations was recorded. After this, these samples were further divided into 4 subgroups based on immersion liquids where 3 samples from each group were placed in each liquid.

- Sub Group i) Soft Drink- Coca Cola
- Sub group ii) Turmeric (1 tsp in 150 ml of water)
- Sub group iii) Coffee (1 tsp in 150 ml of water)
- Sub group iv) Distilled water

All specimens were kept immersed in the liquids for 14 days at 37°C temperature and the staining solutions were replaced every week to avoid bacterial growth. The specimens were then rinsed in distilled water and dried on absorbent paper. The colour evaluation was done against a white background. The spectrophotometer measurements were repeated and the colour differences between the measurement data at t0 and t1 were calculated. According to CIE L∗a∗b∗ colour system, the colour variation can be obtained using a system of coordinates of the CIE L∗a∗b∗ scale: L (lightness, 0–100), a (−a∗ = green, +a∗ = red), and b (−b∗ = blue, +b∗ = yellow). So, the colour variation ΔE of each specimen was calculated using the following equation: ΔE = [(L1∗ - L0∗) 2 + (a1∗ - a0∗) 2 + (b1∗ - b0∗) 2] 1/2. Scores with ΔE>3.3 correspond to visually perceptible differences considered clinically unacceptable.

Results

The microhardness test revealed that the best performance was achieved in Mylar strip (86.1± 1.4) (Group A) compared to mylar (Group D) ($p<0.01$). Group B glycerine and Group C K-Y JELLY® showed a comparable result with each other. The mean ΔE values and the statistical analysis after 14 d of immersion in the different staining solutions are shown in Figure 1. Coffee induced a significant increase in discoloration of the XTE specimens. The specimens in Group C showed a significant increase in ΔE variation compared to Groups A, B, and D ($p<0.001$). The specimens polymerized in air (group D) were almost always more susceptible to the chromatic changes compared to the other groups.
ΔE value mean scores with ± SD

GROUP / SUBGROUP	GROUP A MYLAR STRIP	GROUP B GLYCERINE	GROUP C KY JELLY	GROUP D AIR CURE
1 SOFT DRINK	32.64 ± 0.61	24.43 ± 1.52	28.62 ± 0.71	41.15 ± 3.8
2 TURMERIC	35.21 ± 2.25	32.40 ± 0.89	31.20 ± 1.1	49.3 ± 5.6
3 COFFEE	34.21 ± 1.23	38.62 ± 2.64	40.31 ± 1.47	53.62 ± 4.5
4 DISTILLED WATER	1.15 ± 0.31	1.09 ± 0.06	1.02 ± 0.03	4.09 ± 1.6

Figure 1. Spectrophotometric analysis

Vicker's Hardness Test: Microhardness Test results showed highest values for specimens cured under Mylar Strip followed by Glycerine and K-Y Jelly. There was no significant difference between Group B and Group C.

GROUP	GROUP A MYLAR STRIP	GROUP B GLYCERINE	GROUP C KY JELLY	GROUP D AIR
VHN	86.1 ± 1.4	76.8 ± 1.9	78.3 ± 1.7	48.4 ± 2.1

Figure 2. Vickers Hardness Number

Discussion

This study exhibits that the OIL affects the microhardness of the composite specimens and decreases the colour stability of resins. Ruyter IE in his study has suggested that OIL increses adsorption of surface material by increasing the contact area available (Shawkat et al., 2009). Removal of the outer layer of resin composites affected by oxygen inhibition polymerization is usually required to produce a harder, more resistant, and more esthetically acceptable surface4.Several studies show that a harder surface is obtained when composites are cured in the absence of oxygen using a mylar matrix (Shawkat et al., 2009; Burtscher, 1993). The degree of polymerization and OIL formation is affected by many factors such as initiator (Eliades & Caputo, 1989; Suh, 2004). Filler content and size, color, light intensity, curing time (Vallittu, 1999; Ruyter, 1981; Lee et al., 2004). For the Hardness test the group with Mylar strip performed the best followed closely by the K-Y jelly and glycerine group. It is speculated that since a Mylar strip blocks any contact with air, only the oxygen already present within the composite contributes to OIL formation, thus minimizing OIL formation. However, when glycerin is used, minute amounts of oxygen in the glycerin in addition to that already existing on the composite surface may support the formation of an OIL, leading to a greater amount of OIL formation than that observed with the Mylar strip method. When glycerin is applied to previously cured composites and additionally cured, initiators remaining in the OIL might be converted into free radicals, supporting the occurrence of additional polymerization in an oxygen-restricted state (Eliades & Caputo, 1989). The same phenomenon explains the performance of K-Y Jelly. It is glycerol and

hydroxymethylcellulose containing water based gel that provides greater control of use without having to contact the restorations surface.

In the present study, the test samples were exposed to commonly consumed beverages such as coffee, cola and turmeric, a common colorant used in Indian food , in solution form. The samples were subjected to the solutions for 14 days. Measurement of color change can be assessed by visual and instrumental methods. Quantitative evaluation of color change by means of visual assessment is not possible or even useful most of the times, besides presenting low producibility. According to literature, these CIE Lab Score systems are found to be more precise in comparison with measurements obtained from the calorimeter. The greatest color change in all groups was caused due to the coffee solution ($P > 0.001$). With a ΔE value >3.3 in all groups, indicating a visually perceptible, unacceptable color change. Nanohybrid composite showed greatest staining to coffee, then turmeric which is in accordance with studies.

Coffee has been found to be a stronger chromatogen than cola. The yellow colorants of coffee are less polar. Absorption and penetration of the colorants into the organic phase of the resin-based materials is probably due to the compatibility of the polymer phase with yellow colorants of coffee. This aspect is in consensus with the study conducted with respect to colour change in cola, in the present study a slight change in color was caused due to Coca-Cola. These results are in agreement. Polishing results in a higher surface hardness than that produced when a matrix is used, effective in preventing discoloration, and is advantageous in achieving a satisfactory surface and marginal adaptation. Clinically, however, the OIL may not be able to be completely removed and can remain in deep pits and fissures even after polishing. Therefore, in order to reduce the amount of OIL on composites as much as possible, it is recommended that a Mylar strip be used for proximal and bucco-lingual cavities, and that glycerin or K-Y Jelly be applied for occlusal surfaces and hard-to-reach cavities during curing.

Conclusion

This study concludes that K-Y Jelly performs similar to glycerine application and Mylar strip has the most superior performance in terms of specimen hardness. Maximum stain was caused by coffee solution.

References

Burtscher P. Stability of radicals in cured composite materials. Dent Mater 1993; 9: 218–221.

Eliades GC, Caputo AA. The strength of layering technique in visible light-cured composites. J Prosthet Dent 1989; 61:31–38.

Eliades GC, Caputo AA. The strength of layering technique in visible light-cured composites. J Prosthetic Dent. 1989;61:31–8.

Garoushi S, Sailynoja E, Vallittu Pk, Lassila L. Physical properties and depth of cure of a new short fiber reinforced composite. Dent Mater 2013; 29: 835–841.

Garoushi S, Vallittu Pk, Lassila LVJ. Short glass fiber reinforced restorative composite resin with semi-inter penetrating polymer network matrix. Dent Mater 2007; 23: 1356–1362.

Lee TY, Guymon CA, Sonny Jonsson € E, Hoyle CE. The effect of monomer structure on oxygen inhibition of (met)acrylates photopolymerization. Polymer 2004; 45: 6155–6162.

Ruyter IE. Unpolymerized surface layers on sealents. Acta Odontol Scand 1981; 39: 27–32.

Shawkat ES, Shortall AC, Addison O, Palin WM. Oxygen inhibition and incremental layer bond strengths of resin composite. Dent Mater 2009; 25: 1338–1346.

Suh BI. Oxygen-inhibited layer in adhesion dentistry. J Esthet Restor Dent 2004; 16: 316–323.

Tezvergil-Mutluay A, Lassila LVJ, Vallittu PK. Incremental layers bonding of silorane composite: the initial bonding properties. J Dent 2008; 36: 560–563.

Vallittu PK. Unpolymerized surface layer of autopolymerizing polymethyl dimethacrylate resin. J Oral Rehab 1999; 26:208–212.

Weinmann W, Thalacker C, Guggenberger R. Siloranes in dental composites. Dent Mater 2005; 21: 68–74.