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EFFECT OF SELF ADHESIVE NANO-FILLED COATING ON THE COLOR STABILITY AND GLOSS OF NANOCOMPOSITE RESTORATIVE MATERIAL

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ABSTRACT **Objectives:** To evaluate the effect of self adhesive nanofilled coating on the color stability and gloss of Nanocomposite Restorative material.

Methods: 120 cylindrical discs were prepared from nano-composite resin with dimensions 6.5mm x 2mm. 60 of 120 specimens were analysed for baseline colour change value (ΔE) using Spectrophotometer and rest of the 60 specimens were analysed for surface gloss value using glossometer. All the specimens were stored in distilled water at 37 ^{0}C. Statistical analysis was performed using the statistical software SPSS for Windows, version 16.0. Two- way analysis of variance (ANOVA) was used to calculate the effects of material, staining agent and the interaction between the color change values. Comparison of mean was performed using Tukey's HSD test.

Results: The baseline color change value for Group I (nanocomposite) (ΔE=1.25) was significantly lower than that for Group II (nanocomposite + G coat) (ΔE=1.27) (p=0.001). The mean baseline gloss index value was significantly higher for Group II (11.2) as compared to Group I (6.62) (p=0.000). However after immersion in coffee for 21 days without brushing, the color change values for Group I (ΔE=3.72) were significantly higher than for Group II; and gloss index value significantly reduced for both the groups. The samples which were brushed showed lower gloss index values than the non-brushed ones.

KEYWORDS : G coat, Glossometer

INTRODUCTION:

As the technology has advanced over the years, paradigm of dentistry has shifted towards improving the esthetics of restorations along with providing strength and restoring function. Composite resins were developed in 1950s which contained glass filled poly methyl methacrylates.[1] Since then composites have evolved giving rise to newer variants like nanocomposites. Nanocomposites contain filler particles ranging 5-100 nm giving it high wear resistance as well as polish-ability. [2] Good color matching of composite resins with high quality finish gives rise to excellent surface gloss. The biggest challenge to long term survival of composite restorations is their discoloration over time on exposure to various beverages and food items. This could be due to rough surface of the restoration or due to partial curing of the material leading to adsorption and absorption of discoloring agents.[3]

Recent research has suggested application of unfilled resin as surface layer over esthetic restorations which forms a protective layer thus masking surface irregularities and increasing the color stability and gloss. It also spreads mechanical stresses uniformly over the restoration surface thus increasing fracture toughness and wear resistance.[4] Regular Brushing forms the fundamental and vital part of dentistry; failure to do say leads to accumulation of plaque and calculus. Brushing is advised even over the restorations to prevent the above mentioned sequelae.

However, brushing can have microscopic effect on the surface of the restoration affecting its color stability and also on the surface layer of unfilled resin affecting gloss.[5] Thus, aim of the present study was to assess the effects of coffee on the color stability of restorative nanocomposite resin with or without a superficial coating of self adhesive unfilled resin and correlating it with regular brushing. Null hypothesis tested were: 1) unfilled resins have no effect on color stability and surface gloss of nanocomposites on immersion in coffee; 2) regular brushing has no effect on color stability and surface gloss of nanocomposites.

MATERIALS AND METHODS:

The present in vitro study was conducted in the Department of Pedodontics and Preventive Dentistry at ITS-CDSR, Ghaziabad, India after obtaining the approval from the Institutional Ethics Committee.

Sample Preparation:

120 cylindrical discs were prepared from nano-composite resin of shade A1 (N Tetric, Ivoclar Vivadent) with dimensions 6.5mm x 2mm. Composite material was placed in the brass mould and pressed between mylar strips supported by microscopic slides. The material was light cured according to manufacturer's instructions. 60 of 120 specimens were analysed for baseline colour change value (ΔE) and rest of the 60 specimens were analysed for surface gloss value. All the specimens were stored in distilled water at 37 ^{0}C.

Colour Change:

Baseline colour measurements were done for all the 60 samples which were then divided into 2 groups containing 30 samples each with Group I containing discs made with nano-composite whereas, Group II containing discs made with nanocomposite followed by additional superficial coating of unfilled resin (G Coat Plus , GC). All the specimens were immersed in coffee for 21 days at room temperature. Group I & II were further divided into two subgroups [Group I(a), I(b), II(a), II(b)]. Samples from Groups I(a) and II(a) were not brushed and Groups I(b) and II(b) were brushed everyday for 21 days. After 21 days all the samples were rinsed with distilled water for five minutes and blotted dry with tissue paper. The color measurements were again done using spectrophotometer. Measurements were taken using the Commission International de (CIE) L*a*b* system, which measures color relative to a standard illumunant (A) against a white background. L* represents the lightness coordinate, with values ranging from 0 (black) to 100 (white); a* and b* represent chromaticity coordinates

along a red-green and a yellow blue axis, respectively, with positive a* values indicating a shift to red, negative a* values indicating a shift to green, positive b* values indicating a shift to yellow and negative b* values indicating a shift to blue. Measurements were repeated 3 times for each specimen Color change value (ΔE*) was calculated by software on the spectrophotometer using the following equation: 20 ΔE*= [(L1*-L0*) 2 + (a1*-a0*) 2 + (b1*-b0*) 2] 1/2.

Change In Gloss:
The 60 samples reserved for gloss measurements were similarly divided into Groups I(A), I(B), II(A) and II(B) containing 15 samples each. All the samples were subjected to testing using Glossometer (Gloss meter 300 GU) to obtain baseline gloss index values. After 21 days of storage under respective conditions, gloss index values were repeated for all the specimens.

Statistical Analysis:
Statistical analysis was performed using the statistical software SPSS for Windows, version 16.0. Two- way analysis of variance (ANOVA) was used to calculate the effects of material, staining agent and the interaction between the color change values. Comparison of mean was performed using Tukey's HSD test.

RESULTS:
A total of 120 samples of nanocomposite material were prepared out of which sixty received a final coating of G coat plus.

The baseline **color change** value for Group I (nanocomposite) (ΔE=1.25) was significantly lower than that for Group II (nanocomposite + G coat) (ΔE=1.27) (p=0.001). However after immersion in coffee for 21 days without brushing, the color change values for Group I (a) (ΔE=3.72) were significantly higher than for Group II(a) (ΔE=3.15) (p=0.000). The samples which were brushed regularly [Group I(B) & Group II(B)] showed lower color change values for both the groups with a significant difference between the groups (p=0.000).

Table-1: Mean Color Change Values For Both The Groups Along With Mann Whitney Statistic Results

Group	Mean ΔE value (baseline) n=30	Mann Whitney statistic	Mean ΔE value (after 21 days without brushing) n=15	Mann Whitney statistic	Mean ΔE value (after 21 days with brushing) n=15	Mann Whitney statistic
Nanocomposite (Group I)	1.25	P= 0.001	3.72	P=0.000	2.71	P=0.000
Nano composite + G- coat (Group II)	1.27		3.15		1.71	

Table-2: Mean Gloss Index Values For Both The Groups Along With Mann Whitney Statistic Results

Group	Mean gloss index value (baseline) n=30	Mann Whitney statistic	Mean gloss index value (after 21 days without brushing) n=15	Mann Whitney statistic	Mean gloss index value (after 21 days with brushing) n=15	Mann Whitney statistic
Nanocomposite (Group I)	6.62	P= 0.000	4.94	P=0.000	4.82	P=0.000
Nano composite + G- coat (Group II)	11.2		8.22		6.83	

The mean baseline **gloss index** value was significantly higher for Group II (11.2) as compared to Group I (6.62) (p=0.000). After immersion in coffee for 21 days, gloss index value significantly reduced for both the groups (I & II) although Group II (a) (8.22) still had higher gloss index values as compared to Goup I(a) (4.94) without brushing. The samples which were brushed showed lower gloss index values than the non-brushed ones with the Group II (b) (6.83) showing significantly higher values than Group I (b) (4.82).

DISCUSSION:
After analysing the results of the present study, the null hypothesis was rejected as nanocomposite with self adhesive protective coating showed better color stability and surface gloss after 21 days of of immersion in coffee and regular brushing increased color stability but reduced surface gloss of restoration.

The results of the present study showed significant change in color values for all the groups after immersion in coffee. Similar results were observed by many authors. Topcu et al [6] and Gupta et al [7] observed high staining of samples on exposure to coffee because of adsorption and absorption of Tannic acid present in coffee in the organic phase of composites. Composite resins can have discoloration which can be intrinsic or extrinsic in nature. Intrinsic discolouration depends on the nature of filler, matrix and photo-initiator. Completely polymerized composite resin undergo lesser discolouration as compared to a partially polymerized resin. Extrinsic discoloration can be caused by absorption or adsorption of colouring agents in foods and beverages.[8-11] This type of discolouration forms the most important factor affecting the color stability and esthetic longevity of the restoration. [8-13] Along with the effects of colorants, extrinsic discoloration is also associated with structural, physical and chemical properties of composite resins which affects hydrophilicity, water solubility and sorption. It also depends on quantity of filler particles, nature of staining solution and interaction between the staining solution and composite resin.[14-16] Composite resins containing lesser amount of filler particles and higher matrix content absorb more water at the interface causing breakdown of filler by hydrolytic reaction, thus having less color stability. Size of filler particles also have significant effect on color stability as smaller filler particles are less prone to ageing discoloration making them less color permeable as compared to larger filler particles. The extent of water sorption depends on the resin content and strength at interface between resin and filler. High water sorption leads to expansion of resin causing micro cracks and gaps at interface allowing discolouration.[17-18] A study done by Subramanya et al [19] found that water soluble dyes like tannins are highly reactive and attracted on the surface of composites due to the hydrophilic nature of polymethyl methacrylate. Topcu et al [6] showed that UDMA has lower staining because of its less viscosity and less water absorption and maximum polymerization with visible light. TEGDMA and Bis-GMA causes increased hydrophilic property and water sorption as compared to UDMA.[20] The introduction of nanotechnology has led to the development of nanocomposite resins which contain nanoparticles ranging between 5-100 nm in diameter and high filler loading of upto 79.5%. [21] They have high color stability due to their high filler content and smaller filler particles which corresponds to the results of the present study. [21]

G-Coat PLUS is a single dispersion self adhesive nanoparticle-filled protective coating for tooth coloured restorations. The liquid coating provides improved aesthetics, strength, toughness and protection of restoration as it contains uniformly dispersed nanofiller particles. No final polishing of the Restoration is required after application of G-Coat PLUS and provides long lasting gloss and smoothness.[22]

Results of the present study showed that baseline **color change** value for nanocomposite restorations was significantly lower than that for restorations with application of G coat (p=0.001). This can be due to the smooth surface created by G coat plus which forms a barrier between the restoration and coloring agent to prevent direct contact thus increasing color stability. Similar results were observed by Manabe et al [23] and Nuaimi et al [24].

The samples which were brushed regularly showed significantly lower color change values (p=0.000) due to regular removal of the plaque and accumulated colorants on the surface dissociating them from the surface and decreasing prolonged exposure of restoration to colorants.

A significantly higher gloss index was observed for restorations after application of G coat as compared to restorations without application of G coat (p=0.000). This can be due to the smooth and finished surface produced by G coat giving the surface increased shine and gloss.

The samples which were brushed showed lower gloss index values than the non-brushed ones. This is explained by the wear of G coat and restoration surface caused by tooth brushing leading to erosion of resin, filler loss and debonding at resin-filler. Similar results were reported by Haldal et al. [25]

Nano-Composite resins have high patient acceptability as esthetic restorative material in anterior as well as posterior teeth in addition to strength. However, further research is required to study the microscopic changes taking place over and inside a restoration when placed in various drinking solutions, with and without the application of different surface protective agents available.

CONCLUSION:

Following conclusions can be drawn from the results of the present study:

- Coffee decreases the color stability and surface gloss of restorative material.
- Superficial protective coating of dispersed nanofilled resin increase the color stability as well as gloss of nanocomposite restorative resin material.
- Regular brushing increases color stability but decreases surface gloss of nanocomposite restoration with or without the application of protective surface coating of nanoparticles.

Clinical Implication:

Clinical implications of the present study include:

- Surface protective coating of nanofilled resin over nanocomposite restorations is advised as it improves color stability and superficial gloss of restoration, thus, reducing chairside working time.
- Regular brushing is advised over the restoration as it increases the color stability of restoration.

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