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Evaluation of the effect of various types of fluoride varnishes on color stability of a composite resin

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Original Article

Abstract

BACKGROUND AND AIM: Fluoride varnish as an extrinsic factor may cause discoloration in tooth-colored restorative materials. This research compared the impact of different fluoride varnishes on color change of a composite restorative material.

METHODS: This laboratory experimental study was conducted on 40 specimens of flowable composite resin were divided into four groups based on the brand of applied varnishes (Durashield, Nupro, Fluorilaque, and Profluoride varnishes) (n = 10). Color measuring (ΔE) was performed using the easy shade device and according to Commission Internationale de l'Eclairage (CIE) L*a*b* system at three times: 24 hours after immersing in artificial salvia (baseline), 24 hours after fluoride varnishes application and after brushing. The amount of color changes was calculated for all of the specimens as follows: ΔE1 (difference between fluoride application-base line), ΔE2 (difference between brushing-fluoride application), and ΔE3 (difference between brushing-base line). $P < 0.05$ was considered as significant. Statistical analysis was performed by one-way ANOVA and post-hoc Tukey.

RESULTS: The maximum and minimum color changes after applying varnishes were observed by Nupro and Profluoride, respectively. A significant difference was observed between ΔE 1 values of all types of studied varnishes ($P < 0.01$) except Durashield and Fluorilaque ($P = 0.35$). After brushing, no significant difference was shown between color change of stained specimens due to Durashield, Fluorilaque, and Nupro. There was no significant difference between ΔE 3 values of Durashield and Fluorilaque.

CONCLUSION: Trends of color change after using all studied varnishes were clinically acceptable (ΔE < 3.3). Durashield, Nupro, Fluorilaque, and Profluoride varnishes can be used without adversely affecting the color of flowable composite resin.

KEYWORDS: Fluoride Varnish; Discoloration; Resin Composite

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For more than 30 years, fluoride varnish is being applied as an anti-caries material as well as in treating high sensitive tooth.[1] Fluoride varnish is a professionally used adherent agent which contains a high amount of fluoride in an alcohol based solutions of natural varnishes.[2] Fluoride varnish retains fluoride adjacent to the tooth surface for a period. It may be applied to the enamel, dentine or cementum of the tooth to prevent decay, remineralize the tooth surface and to treat dentine hypersensitivity. The concentration and form of fluoride may vary depending on the manufacturer, but most fluoride varnishes contain 5% sodium

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fluoride.[3] The mechanism of action for fluoride varnish is similar to a fluoride mouthwash. Calcium fluoride crystalline (CaF_2) deposits on the tooth surface and later convert to fluorapatite during remineralization.[4] Easy application, safety and easily being accepted by patients are the main reasons why it has been broadly applied. Furthermore, the amount of absorbed fluoride ions by tooth structure in this manner increases, compared to other methods. Different types of fluoride varnishes are available in the market which could contain either sodium fluoride with high concentration of fluoride ion (22600 ppm) or difluorosilane with lower concentration of fluoride ion (1000 ppm). Sodium fluoride based varnishes have a temporary effect on color of teeth and could have effects on the color of composite resin restorative materials.[5-7]

Discoloration of tooth-colored restorative material is the main reason to replace the fillings.[8] Color stability is an important factor for the long-term success of esthetic restorations. Under oral conditions, esthetic restorations may be exposed to light, moisture, stain and mechanical wear, which often result in esthetically undesirable color changes. Remineralizing agents such as fluoride varnishes used for reducing caries may also cause changes in color and surface roughness of the dental materials. All of the composite restorations would have color changes caused by their contact with colored compounds. These color change may either be clinically considerable or not. The extent of color stability of composites depends on the size of fillers, the amount of the matrix resin, and the type of the color releasing medium.[9-12]

There is limited information on the effects of fluoride varnishes on color change of composite resins. The extent of discoloration of various composites is different depending on the type and texture of composite resins and the chromogenesis of the medium in which the composite is preserved.[9,13] This study was done to investigate the impact of different brands of fluoride varnishes on the color change of flowable composite resin. The null hypothesis was that use of fluoride varnishes does not influence on color change of composite resin.

Methods

This laboratory study was conducted on 40 specimens of flowable composite resins (Tetric flow, Ivoclar Vivadent, Schaan, Liechtenstein). Cylindrical plastic molds of 9 mm in diameter and 2 mm in height were used to prepare specimens. After the composites were placed in the molds, a glass slide of 1 mm thick was placed on top of mold to prevent air trapping and to create a smooth surface. The specimens were cured for 40 seconds using High Power Intensity Astralis 7 device (Ivoclar Vivadent, Liechtenstein) with an intensity of 750 mw/cm^2.

Then, the upper surface of specimens was wet polished using a composite polishing kit (SofLex, 3M, USA). The specimens were immersed in artificial salvia solution inside an incubator at 37 °C for 24 hours. Then, they were divided into four groups.

- Group 1: Sodium fluoride 5% varnish Durashield (Sultan, USA) (n =10)
- Group 2: Sodium fluoride 5% varnish Nupro (Dentsply, USA) (n = 10)
- Group 3: Sodium fluoride 5% varnish Profluoride (Voco, Germany) (n = 10)
- Group 4: Sodium fluoride 5% varnish Fluoride (Pascal, USA) (n = 10).

Table 1 presents characteristics of materials used in this study (Table 1).

The color measurement was performed using easy shade spectrophotometer

(VITA Zahnfabrik, Germany) as follow:

1. Baseline evaluation (Measurement I):

Each sample was immersed in individual glass container with artificial saliva and placed at 37 °C for 24 hours, then color measuring was performed.

2. 24 hours following application of fluoride varnish (Measurement II):

Table 1. Characteristics of materials

Products	Composition	Manufacturer
Composite: Tetric flow	BISGMA, UDMA, triethylene glycol Dimethacrylate, inorganic filler 67.8% by weight (barium glass, ytterbium trifluoride, Silicone dioxide, fluorosilicate glass)	Ivoclar Vivadent, Schaan, Liechtenstein
Durashield fluoride varnish	Sodium fluoride 5%	Sultan/USA
Profluoride fluoride varnish		Voco/Germany
Nupro fluoride varnish		Dentsply/USA
Fluorilaque fluoride varnish		Pascal/USA

BISGMA: Bisphenol A-glycidyl methacrylate; UDMA: Urethane dimethacrylate

All the specimens were blot to dry and fluoride varnishes were applied using a special applicator on the outer surfaces of specimens, and after 5 minutes, the specimens were again immersed in new artificial salvia and placed at 37 °C for 24 hours, then color measuring was performed again.

3. 24 hours after brushing (Measurement III):

All the specimen surfaces were cleaned by an electrical toothbrush (Oral-B) and toothpaste (Colgate Total-Colgate-Palmolive Ltd., India) for 5 seconds. The specimens were immersed in new artificial salvia and stored at 37 °C for 24 hours, then color measuring was performed for the third time.

The indices L, a, and b were calculated and recorded for all samples on white background based on Commission Internationale de l'Eclairage (CIE) L*a*b* system by Easy Shade device. L* refers to value, range from 100 (perfect white) to 0 (perfect black). The parameters a* and b* were respectively considered as chromaticity on red-green axis and yellow-blue axis, with red (+a*), green (-a*), yellow (+b*), and blue (-b*). Then, color changes of specimens were calculated by Equation 1:[14,15]

$$\Delta E = [(\Delta L)^2+(\Delta a)^2+(\Delta b)^2]^{1/2}$$

ΔE1 = Difference between measurement II-I,

ΔE2 = Difference between measurement III-II,

ΔE3 = Difference between measurement III-I.

The extent of clinically acceptable color change was considered as 3.3 (ΔE < 3.3).[9]

Statistical calculation of findings was conducted with SPSS (version 20, IBM Corporation, Armonk, NY) and one-way ANOVA and post-hoc Tukey. $P < 0.05$ was considered as significant.

Results

Mean color change, separately for each varnish was presented in table 2. The maximum and minimum color changes after applying varnishes were occurred in Nupro (ΔE1 = 1.90 ± 0.20) and Profluoride (ΔE1 = 0.58 ± 0.06) groups, respectively (Table 2). Color change of composite specimens by Nupro was significantly higher than Durashield and Profluoride and Fluorilaque ($P < 0.01$, $P < 0.01$, $P < 0.01$; respectively). Profluoride caused changes in color of specimens significantly less than Durashield and Nupro and Fluorilaque ($P < 0.01$, $P < 0.01$, $P < 0.01$; respectively). No significant difference was observed between ΔE1 values of Durashield and Fluorilaque ($P = 0.35$).

Table 2. Mean ± SD of color change

Groups	ΔE1* (mean ± SD)	ΔE2** (mean ± SD)	ΔE3*** (mean ± SD)
Durashield	1.38 ± 0.09	1.99 ± 0.17	1.85 ± 0.17
Nupro	1.90 ± 0.20	1.95 ± 0.24	1.14 ± 0.05
Profluoride	0.58 ± 0.06	0.61 ± 0.05	0.85 ± 0.04
Fluoirlaque	1.49 ± 0.18	1.93 ± 0.09	1.80 ± 0.08
P	< 0.01	< 0.01	< 0.01

*ΔE1: Color change between fluoride application-base line, **ΔE2: Color change between brushing-fluoride application, ***ΔE3: Color change between brushing-base line, SD: Standard deviation

After brushing, no significant difference was showed between ΔE3 values of specimens due to Durashield, Fluorilaque, and Nupro, but these values were significantly higher than that of Profluoride ($P < 0.01$, $P < 0.01$, $P < 0.01$; respectively). There was no significant difference between ΔE3 values of Durashield and Fluorilaque, but these values were significantly higher than that of Nupro and Profluoride ($P < 0.01$, $P < 0.01$; respectively).

The ΔE 3 value of Profluoride was significantly lower than that of Nupro ($P < 0.01$). ΔE1, ΔE2, and ΔE3 of all specimens were not clinically noticeable. Figure 1 illustrated the mean values of ΔE1, ΔE2, and ΔE3 for all groups.

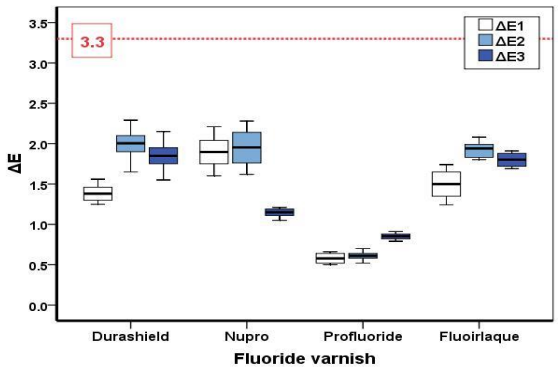

Figure 1. Mean ± SD (standard deviation) of color change

ΔE1: Color change between fluoride application-base line, ΔE2: Color change between brushing-fluoride application, ΔE3: Color change between brushing-base line

Discussion

In this research, the impacts of four common types of fluoride varnishes on the extent of color change of flowable composite were examined. Because flowable composite resins commonly used in pediatric dentistry to restore small defects of deciduous teeth or sealing deep pits and fissures of permanent molar teeth.[16] The results showed clinically acceptable color change of the specimens after fluoride varnish application (i.e., $\Delta E < 3.3$). To examine color of the composite, easy shade spectrophotometer instrument was used, which is the most accurate measure for examining color changes. Applying this instrument is one of the advantages of our research.[9] This results are in line with that of the Autio-Gold and Barrett study,[17] in which the authors investigated the impacts of fluoride varnish on the ionomer glass and composite restorative materials and concluded that fluoride varnish caused clinically acceptable color change in composites ($\Delta E < 3.3$).

A factor influencing the extent of color stability is the surface roughness of the materials; moreover, some studies have reported an association between the extents of polishability and the amounts and dimension of filler particles.[9,18]

In Prabhakar et al. study,[19] application of fluoride varnish on the glass ionomer material resulted in a significant change in color and surface roughness but after brushing no statistically significant color change was observed. It was observed that fluoride varnish on setting formed a layer on teeth or restorative material which might be the cause of the discoloration. Brushing causes reduction in color change probably due to partial removal of the varnish layer. They have also represented that the composition and size of the filler particles affect both color and surface roughness of the dental materials. The relative susceptibility of glass ionomer to color alteration could be related to the porosity of the glass particles. Furthermore, glass ionomer shows more color change due to its hydrophilic property and greater surface destruction.[12] Researchers reported that hydrophilic materials stain more than hydrophobic materials.[6]

Debner et al.[20] showed that sodium based fluoride varnishes could cause temporary color change of both teeth and restorative materials; however, none of those changes were clinically considerable, which is compatible with the results from the present study.

The study of Salama et al.[21] on the impact of fluoride varnish applications on the surface of restorative materials showed that the surface roughness of restorative materials is increased due to applying fluoride varnish,

which itself could justify the color change of composite restorative materials.

Further studies are recommended on various types of tooth-colored restorative materials and other forms of fluoridated protective agents.

Conclusions

The color change caused by the influence of fluoride varnishes Durashield, Nupro, Fluorilaque, and Profluoride were not clinically considerable ($\Delta E < 3.3$) and can be used without adversely affecting the color of restorative material.

Conflict of Interests

Authors have no conflict of interest.

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