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COMPARATIVE EVALUATION OF GIOMER COATING MATERIAL VERSUS ICON RESIN INFILTRATION IN MASKING OF WHITE SPOT LESIONS (AN IN VIVO STUDY)

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ABSTRACT

Objective: This study was performed for comparative evaluation of the Giomer coating material versus Icon resin infiltration in masking White Spot Lesions (WSLs). **Materials and methods:** In this study, twenty patients were involved. Each patient had at least two WSLs in their anterior teeth (total 40 WSLs). The WSLs were divided into two equal groups randomly, control group (Icon), and intervention group (Giomer coating material). According to the instructions provided by the manufacturers, all materials were applied. The WSLs color change (ΔE) was assessed by Vita Easyshade V device at the following evaluation periods: T0: before the application of the materials, T1: immediately following treatments, T2: three months later, T3: six months later, and T4: one year later. Data were recorded and statistically analyzed. **Results:** The statistical analysis of each group showed that after immediate application, the ΔE for each group significantly improved. However, the ΔE of all groups significantly dropped over the time. The Icon group showed significant improvement in ΔE more than Giomer group. **Conclusions:** Icon resin infiltration technique is superior to Giomer in esthetics improvement. Giomer can be used for a short time as a prevention protocol and control of caries progression.

KEYWORDS: Color masking; Giomer; Icon resin infiltration; White spot lesions.

INTRODUCTION

The white spot lesion (WSL), which is regarded as the early stage of enamel demineralization, serves as the initial clinical indicator of dental caries and emerges on the tooth surface. The white lesion may develop into a cavity if the demineralization process persists [(1)].

In order to treat WSLs treatment, there are two main approaches: the first, or non-invasive approach, relies on remineralizing agents. The second strategy uses minimally invasive techniques like bleaching, microabrasion, or caries infiltration to conceal and improve the aesthetic look [(2)]. The remineralization of WSLs can be facilitated by conventional fluoride varnishes, yet it does not occur in the lesion body's deeper parts because the remineralization occurs at the surface first, reducing porosity and block the further ionic penetration beneath the surface [(3,4)].

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Alternatives have been suggested due to the limits of fluoride varnishes, such as coating materials with S-PRG (surface pre-reacted glass-ionomer) fillers that can release mineral ions in addition to fluoride release and recharge. It prevents caries, stops demineralization, promotes remineralization, and lessens acid attack from cariogenic bacteria because to its acid buffering capabilities [5]. Giomer dental substance as the PRG Barrier Coat contains S-PRG filler and is known for its bioactive properties brought on by the slow release of many ions beside fluoride ions [6].

Resin infiltration is a minimally invasive method for managing WSLs. It entails acidic erosion of the lesion surface to remove the outer layer, followed by the infiltrating of low viscosity, high penetration coefficient resin, such as Icon, into the lesion body. By entering and occluding the porous enamel, which forms a physical barrier that prevents acids and cariogenic bacteria from further penetrating them, the resin infiltration can enhance the lesions hardness and stop further loss of tooth tissue. It can also improve aesthetics by concealing the whitish, opaque color of the WSLs [7].

Furthermore, some of the general and physical factors connected to the visual technique can be controlled through the use of spectrophotometers (Vita Easyshade V devices) for color determination. They also have the benefit of quickly giving factual and quantitative data which, when compared to human shade assessment, enable objective color assessment and deliver more accurate and reproducible results [8,9].

In our study, we choose to compare the Giomer (PRG Barrier Coat) and Icon resin infiltration on esthetic improvement of WSLs. The color change measured by VITA Easyshade V spectrophotometer along 12 months of follow up. The hypothesis was that the Giomer coating material will improve the esthetic of WSLs, as Icon resin infiltration over a period of one year.

MATERIALS AND METHODS

Two materials were used in this study:

1. Icon resin infiltration (DMG, Hamburg, Germany): It comprised 3 steps for resin infiltration; icon etch, icon dry and icon infiltrant.
2. PRG Barrier Coat Mini-Kit (Shofu Inc., Kyoto, Japan): It consists of PRG Barrier Coat active and base containers.

Ethical approval and consent form:

The institutional Ethics Committee (No.350/466/08/10/19) at the Faculty of Dental Medicine, Al-Azhar University Ethics Committee, gave their approval to this trial. Each patient received information about the study's purpose, provided the consent to participate, and signed a consent form (in regional language) before the start of the study.

Eligibility criteria:

Following were the inclusion criteria: adult patients between the ages of 18 and 30, each patient had at least two anterior teeth with buccal WSLs, good oral hygiene, and each arch has an equal number of permanent teeth (mesial to second molars). Exclusion criteria were: lesions which presented cavity, filling on the labial surface of anterior teeth, presence of stains (intrinsic or extrinsic), and patients with major medical histories or those who smoke.

Sample calculation and Grouping:

Sample size and power tests were conducted based on prior clinical research[10], and they revealed that with a significance level (alpha) of 0.05, a sample size of (15) in each group has a 95% power to detect a difference between means of 5.73 (two-tailed). This number is to be increased to total number of 20 in each group to compensate for losses during follow-up. A total number of (40) non-cavitated WSLs in permanent anterior teeth was collected from (20) patients, each patient has two WSLs that are equally randomly divided into

two main groups (n=20) based on the type of used materials, control group (Icon) and intervention group (PRG Barrier Coat [PRG]).

The color of WSLs was assessed before the application of the materials (T0) by the Vita Easyshade V device (VITA Zahnfabrik, Bad Sackingen, Germany). Prior to color measurement, all teeth with WSLs were scaled and a rubber cup was used to polish the labial teeth surface with a fluoride free pumice paste. The device was calibrated in accordance with the manufacturer's instructions before every patient assessment. The measurement was done after air-drying for 5 seconds and before the complete dryness of the field.

Materials application:

A rubber dam system was used to protect gingival tissues and avoid moisture contamination. According to the instructions provided by the manufacturers, all materials were applied by the same clinician.

1. Resin infiltration (Control):

In the first step, Icon-Etch gel (15%) hydrochloric acid was used for 2 minutes for the purpose of etching the WSLs' surface. Then, the lesion was sprayed with water for 30 seconds, then dried with compressed air for 10 seconds. The second step was applying an ample amount of 99% ethanol (Icon -Dry) to the etched area and letting set for 30 seconds and then the lesion dried thoroughly with compressed air for 10 seconds. The last step was resin infiltrant (Icon-Infiltrant) application for three minutes to enable penetrating. Dental floss was used to remove the residue. After that, a light emitting diode (LED) was used to cure the resin infiltration for 40 seconds, WOOPECKER B-CURE, (Gulin Woodpecker Medical Instrument Co., LTD, China), produces a narrow spectrum of blue light in the 400 to 500-nm range (with a peak wavelength of about 480nm). Then another layer of Icon- Infiltrant was applied for another minute, and then light-cured for 40 seconds. Then the treated WSLs were polished.

2. PRG Barrier Coat:

One of the base containers was broken off, the base container was loaded with one drop of activator and then mixed in the base container using the disposable brush provided. The mixture was applied to the WSLs, leave undisturbed for more than 3 seconds, then light-cured for 10 seconds, and the uncured layer was eliminated following light curing by gently wiping the area with a cotton ball wet with water.

Observation:

The treated WSLs were evaluated post-operatively by Vita Easyshade V device to assess the WSLs' color change (ΔE) by the same operator at the following time intervals; T0: before the application of the materials, T1: immediately following treatments, T2: three months later, T3: six months later, and T4: one year later.

Statistical analysis:

SPSS statistical version 21 was used for the statistical analysis. A one-way ANOVA test was used to compare the efficacy of different materials at different follow-up periods. The post hoc Tukey test was used for multiple comparisons within the two groups, within each group, and compared the two intervals. $P \leq 0.05$ was chosen as the significance level.

RESULTS

Intragroup comparison:

The statistical analysis of each group showed that; after immediate application, the ΔE for each group significantly improved. Also, the difference was statistically significant in all follow-up periods as indicated by the ANOVA test ($P<0.00001$). The post hoc Tukey test showed a significant decrease in the mean value of the ΔE with time.

In the Icon group, the higher (Mean ±SD) were recorded immediately after application (26.99±0.62), followed by (21.93±0.75) and (9.97±0.48) for 3-month and 6-month respectively. While the lower (Mean ± SD) was recorded for the 12-month (2.75±0.26). Data are summarized in **(Table 1).**

TABLE (1) Effect of Icon on color change (ΔE) of WSLs at different periods:

Variable	ΔE (Immediate)	ΔE (3-months)	ΔE (6-months)	ΔE (12-months)	P-value
ICON (Mean± SD)	26.99±0.62^{A}	21.93±0.75^{B}	9.97±0.48^{C}	2.75±0.26^{D}	<0.00001*

**; significant at P ≤ 0.05. Different uppercase letters mean statistically significant. (SD) standard deviations.*

While in PRG group, the higher (Mean ± SD) were recorded immediately after application (19.74±0.57), followed by (14.72±0.78) and (6.32±0.39) for 3-month and 6-month respectively. While the lower (Mean ± SD) was recorded for the 12-month (1.13±0.16). Data are summarized in **(Table 2).**

TABLE (2) Effect of PRG on color change (ΔE) of WSLs at different periods:

Variable	ΔE (Immediate)	ΔE (3-months)	ΔE (6-months)	ΔE (12-months)	P-value
PRG (Mean± SD)	19.74±0.57^{A}	14.72±0.78^{B}	6.32±0.39^{C}	1.13±0.16^{D}	<0.00001*

Intergroup comparison:

The statistical analysis of ΔE among the two groups immediately after materials application, and in all follow-up periods showed that; there were significant differences between them (P=0.00000*). The icon group showed significant improvement in ΔE **(Table 3).**

TABLE (3) Comparison of color change (ΔE) among both groups at different time intervals:

Variable	PRG (Mean ± SD)	ICON (Mean ± SD)	P-value
ΔE (Immediate)	19.74±0.57^{B}	26.99±0.62^{A}	<0.00001*
ΔE (3-months)	14.72±0.78^{B}	21.93±0.75^{A}	<0.00001*
ΔE (6-months)	6.32±0.39^{C}	9.97±0.48^{A}	<0.00001*
ΔE (12-months)	1.13±0.16^{C}	2.75±0.26^{A}	<0.00001*

DISCUSSION

An optical phenomenon causes the early enamel carious lesion (WSLs) to have a whitish appearance. WSLs have an outer layer that appears to be intact, which is followed by the body of the lesion, a porous area underneath the surface. Water, which has a Refractive Index (RI) of 1.33, or air can enter into such pores (RI of 1.00). The earliest enamel carious lesion appears as a clinically apparent white spot due to the ambient light's reflection and scattering caused by the variation in the refractive index (RI) of sound enamel (1.62) and water or air [(11)]. Over time, many treatment approaches that attempt to mask the WSLs' appearance have been created. The most popular technique is minimally invasive resin infiltration, which removes the top layer of the body lesion by etching and then uses capillary action to fill the pores of the lesion with low viscosity unfilled resins. It bridges the gap between prevention and restoration [(12)]. It applies to the minimally invasive intervention principle, protecting the dental structure and avoiding healthy dental tissue from being lost [(13)].

Our results for the Icon group showed that after immediate application, the ΔE was significantly improved, Icon resin infiltration's RI (1.46) may explain this result which is quite similar to that RI of sound enamel. Less light scattering within the enamel resulted from resin replacing the air or water in the microporosities WSLs [14]. Moreover, the resin infiltration improved the microhardness of WSLs, which is clearly caused by a uniform complex formed of TEG-DMA and hydroxyapatite. The mechanical properties and aesthetic qualities of the enamel surface were enhanced by this interaction[15].

However, in the Icon group there was a significant decrease in ΔE with time. This may be due to losing the outer protective layer of the lesion due to acid conditioning and the degradation effect of the material over time allows entrance of the stains and colored agents making the lesion prone to discoloration and staining [16]. Our results are in agreement with Said M et al [17], who evaluated Icon's efficiency and durability in managing WSLs as compared to acidulated phosphorus fluoride by Vita Easyshade. They found that, a considerable enhancement of WSLs aesthetics right after application of Icon. However, after 3 months follow up it was significantly reduced. Also, our results are consistent with Altarabulsi M et al [18], who found that the Icon resin infiltration surfaces exhibited a noticeable rise in the discoloration after 12 months.

While regarding PRG, our results showed significant improvement in ΔE immediately. This may be due to the Giomer varnish showing a high thickness surface that masks the under-enamel WSLs [19]. However, there was a noticeable decline in the ΔE at all follow-up periods in the PRG group. This could be due to the internal acid-base reactions that are ongoing, which are recognized to generate voids and cracks in glass ionomers, may also be responsible for the acidic environment's effect on the material's integrity and potential partial dissolving of the coating layer [20]. Moreover, the water sorption characteristics were provided by the material's hydrophilic component. High water sorption speeds up the deterioration of the substance and the penetration of colorants [21]. This finding was in agreement with Corcodel N et al [22], who evaluated the color stability of resin-modified glass ionomer-based sealant (Clinpro XT) after thermocycling; 1 week; 2 and 4 weeks of immersion. They found that Clinpro XT had staining discoloration even in one week. They explained that could be due to its water sorption capabilities and penetration of colorants into materials.

In comparison between the Icon and PRG groups, there were significant differences at all follow-up periods, with an improved effect of Icon rather than PRG, so the hypothesis was rejected. This may be due to the potential shortcomings in the etching capacity of the PRG (self-adhesive) leading to inadequate penetration of the PRG. As opposed to self-etching adhesives, total-etch dramatically increased the penetration of adhesive ingredients when applied to enamel [23]. Our finding is in agreement with Topal B & Kirzioglu Z [24], who evaluated the success of self-etch Giomer sealant and total-etch resin based sealant in clinical trial. They found that the Giomer showed more discolorations than sealant. They explained this could be due to the Giomer has more significant water absorption rate than total etch sealant, and its rough surfaces could lead to marginal discoloration.

In fact, the PRG is self-etch resin, which insufficiently demineralized the enamel and caused lesser bond strength, swallower adhesive penetration, and shorter resin tags compared to total etching [25]. Previous research has shown that a sealant's capacity to seal is improved by the length of its resin tags, which also reduces nanoleakage [26]. Additionally, the prevention of caries lesion progression depends on how deeply sealants penetrate into the body pores of WSLs [27].

CONCLUSIONS

Icon resin infiltration technique is superior to Giomer in esthetics improvement. However, Giomer can be used for a short time as a prevention protocol and control of caries progression.

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