The Effect of Some Remineralization Materials and Resin Infiltration (ICON) on the Depth of White Spot Lesions

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ABSTRACT

Background: White spot lesions (WSLs) are subsurface enamel demineralization manifested as white opacities which had an esthetic problem. The purpose of this in-vitro study was to evaluate the lesion depth improvement of WSLs following application of fluoride varnish, tooth mousse and resin infiltration (ICON).

Materials and methods: Artificial WSLs were created on 120 premolar teeth using demineralization solution with pH (4-4.5). Samples randomly allocated into four groups; fluoride varnish, tooth mousse, ICON and untreated group. Groups were discolored in Cola and orange juice for 24 hours. Teeth were ground sectioned by longitudinal cutting then these sections examined and photographed under stereomicroscope at 12X magnification then analyzed for lesion depth measurements using Image Pro Plus computer software to record the average lesion depth (µm).

Results: The mean values of lesion depth for WSLs groups in DDW, Cola and orange juice increased after formation of WSLs then decreased with the fluoride varnish, tooth mousse and ICON. There was a statistically significant difference between the WSLs, fluoride and Mousse group in DDW and Cola, while there was no statistically significant effect of ICON on WSL in DDW (p=0.341)and Cola (p=0.210).

Conclusions: Formation of WSLs is associated with significant lesion depth changes and the use of fluoride varnish, tooth mousse and ICON could return minerals or resin to subsurface enamel of WSLs and improve lesion depth in different soft drinks.

Keywords: White Spot Lesions, fluoride varnish, tooth mousse, ICON. **(J Bagh Coll Dentistry 2018; 30(2): 71-75)**

INTRODUCTION

White Spot Lesions (WSLs) represent subsurface enamel demineralization and they represent the early phase of caries formation. Demineralization may take place rapidly within four weeks after the placement of brackets and can stay present even years after treatment due to prolonged accumulation and retention of bacterial plaque on the enamel surface adjacent to the appliances [1,2].

The treatment of WSLs in orthodontic patients included remineralization of subsurface enamel lesion with CPP-ACP (Tooth Mousse) or topical fluoride or filled with low viscosity resin infiltration material (ICON) as non-invasive methods or apply invasive treatment methods such as micro-abrasion or veneer crown.

In vivo study investigated the effect of a dental cream containing CPP–ACP and compared with fluoride mouth rinses on remineralizing white spot lesions using laser fluorescence, where the regression of white spot lesions was seen following the application of CPP–ACP cream [1].

Another in vivo study used sugar-free chewing gum containing CPP–ACP also showed increase acid resistance and promotes remineralization of enamel [3].

The twice daily application of 10-fold diluted CPP–ACP paste resulted in preventing enamel demineralization [4].

Fluoride varnishes have been shown to inhibit demineralization and promote remineralization of enamel. Fluoride varnishes were developed to prolong the contact time between fluoride and enamel and formation of calcium fluoride on enamel surface [5, 6]. The enamel demineralization was reduced by addition of topical fluoride after acid etching [7].

The use of resin infiltration to polished infiltrated lesions are more resistant to staining [8], and resin infiltration significantly improves micro-hardness and demineralization resistance of enamel lesions; these effects are significantly enhanced if resin is applied twice [9], in addition the ICON application before a conventional adhesive do not impair bonding to sound enamel and improve demineralized enamel [10].

Hence, the aim of this in vitro study was to evaluate lesion depth of artificial white spot lesions of enamel before and after treatment with CPP-ACP (Tooth Mousse), topical fluoride varnish and resin infiltration (ICON) following application of these agents.

MATERIALS AND METHODS

Samples

The sample of the study consisted of 120 human permanent premolars which were selected according to the selection criteria of sample from 180 teeth extracted for the purpose of orthodontic treatment from the department of oral surgery at

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After extraction, the teeth were cleaned with tap water and examined with 10X magnifying lens; the teeth must be sound, free from stain, demineralization, decay, fluorosis, enamel defects, restorations and cracks.

The teeth were stored in 0.05% of thymol solution at room temperature in closed container until their use to minimize brittleness of enamel and microbial growth.

Methods

Sample preparation

Each tooth was polished with non -fluoridated pumice slurry and rubber cup bur attached to a low speed hand piece for 10 second. Before the white spot lesions (WSLs) created; the gingival third of buccal surface of sample tooth determined to 6 mm × 6 mm diameter window by adhesive tape while the other surfaces of tooth coated by acid resistance nail varnish around the gingival area of premolar teeth.

Formation of WSLs

The sample teeth was immersed in the demineralization solutions at pH ranged from 4-4.5 at room temperature in closed container to prevent dehydration for 4 weeks. The solution changed every 48 hours to keep the pH constant.

After demineralization, specimens were washed thoroughly with distilled deionized water (DDW), and the nail varnish was removed using acetone then the teeth washed in DDW again. After this procedure each tooth displayed an artificial WSL of 6 mm×6 mm.

WSLs and treatment groups

After WSLs formation; 120 teeth were randomly divided into four groups of 30 teeth each as following:

Control group

Specimens remain untreated, stored in distilled deionized water (DDW).

Fluoride Treatment group

Fluoride varnish applied according to manufacture instructions, where the teeth surface that would be treated with fluoride varnish (5% sodium fluoride varnish contained CAPP-ACP (GC Corporation, Tokyo, Japan) cleaned and dried first before application of fluoride varnish then varnish applied on the tooth surface by using disposable brush. Fluoride varnish remained undisturbed on the teeth for four hours.

CPP-ACP treatment group

Tooth mousse was applied according to manufacture as following:

1. A sufficient amount of Casein phosphopeptide-Amorphous calcium phosphate (CAPP-ACP) tooth mousse (GC Corporation, Tokyo, Japan) applied to the tooth surface using a disposable artistic brush for minimum three minutes.
2. GC tooth mousse leaved as long as possible for additional 3 minute undisturbed and kept on tooth for 30 minutes following application.

Resin infiltration (ICON infiltration) group

Resin infiltration ICON (DMG, Hamburg, Germany). infiltration applied according to manufacture as following: Application of Icon-etch (15% HCl gel) for 2 min, water rinsing and air drying for 30 sec. Application of Icon-dry (ethanol) for 30 sec. then air drying, application of Icon- infiltrant for 3 min., light curing of the infiltrant for 40 sec. each application time was used for all the samples.

Discolouration procedure

Discoloration procedure started after WSL procedure and remineralization procedure (treatment) finished using orange juice and Cola solutions at room temperature for 24 hours.

Histological assessment

After all specimens were grouped and treated; the teeth prepared for ground section which should be preserved in DDW to prevent dryness of teeth, because drying makes the hard tissues brittle and the enamel might chipped off in the process of grinding.

Tooth embedded in wax block then ground sectioning of tooth started by longitudinal cutting of tooth in a bucco-lingual direction by diamond disk bur and micro-motor with water irrigation.

The tooth section was ground down then ground section of tooth lifted and washed with deionized water, oriented on the microscope slide for easy handling and labeling then microscope cover glass was fixed.

The ground section of tooth examined and photographed under stereomicroscope (Stereo Microscope M165C, Leica Corporation, Germany) at 12X magnification under maximum illumination. The ground section photograph measurements were obtained using Image Pro Plus 5.1.0.20 computer software (Media Cybernetics, Silver Spring, Maryland). The software allowed for average depth in (μm) to be recorded across the length of the lesion.

Statistical Analyses

Statistical analyses were carried out with the statistical package IBM SPSS® system for Windows version 21 (IBM Institute Inc., Armonk, NC, USA) which include means, and standard deviations, also One-way analysis of variance (ANOVA) and LSD tests were used to determine whether there was a significant difference in mean of lesion depth (µm) among all study groups.

RESULTS

In DDW group, the mean value of lesion depth was increased after formation of artificial WSLs (125.33 µm) while with the application of fluoride varnish and tooth mousse, the lesion depth decreased (113.06 µm and 115.74 µm) respectively. The resin infiltration (ICON) group showed increasing in lesion depth value (126.14 µm).

One-way ANOVA revealed a significant effect for the type of treatment on the lesion depth (p = 0.000) with a statistically high significant difference between each two groups except effect of ICON group on WSL in DDW (p=0.341) which showed a non-statistically significant difference in the post-hoc (LSD) test.

The mean value of lesion depth increased after immersion of teeth with artificial WSLs in Cola or orange juice. The tooth mousse and resin infiltration (ICON) group showed decrease in lesion depth mean value and the least mean value was found in fluoride varnish group.

One-way ANOVA revealed there was a significant effect for the type of treatment on the lesion depth (p=0.000). A statistically high significant difference between the each two groups while a non-statistically significant effect of ICON group and MI group in Cola (p=0.210) in the LSD test.

WSLs and treated WSLs groups in orange juice that results of one-way ANOVA revealed there was a significant effect for the type of treatment on the lesion depth (µm) (p = 0.000). The post-hoc (LSD test) indicated there was a statistically high significant difference between each two groups (WSLs and treatment groups) except the fluoride and MI tooth mousse treated group where the LSD test showed non-significant difference (p=0.140).

Table1: Descriptive statistics of lesion depth (µm) of study groups in each drink

Study groups		N	Mean	SD
DDW	WSL	10	125.33	1.06
	Fluoride	10	113.06	2.27
	Tooth mousse	10	115.74	2.67
	ICON	10	126.14	0.83
Cola	WSL	10	138.84	1.02
	Fluoride	10	114.09	2.63
	Tooth mousse	10	124.10	3.38
	ICON	10	122.67	2.38
Orange juice	WSL	10	138.42	1.07
	Fluoride	10	116.97	2.80
	Tooth mousse	10	115.22	2.18
	ICON	10	133.74	3.63

Table 2: ANOVA and LSD test of the effect of different treatment modalities on lesion depth of WSLs.

Study groups	ANOVA		Treatment		LSD
	F-test	Sig.			Sig.
DDW	125.34	.000	WSL	Fluoride	.000
				Tooth mousse	.000
				ICON	.341
			Fluoride	Tooth mousse	.003
				ICON	.000
			Tooth mousse	ICON	.000
Cola	168.28	.000	WSL	Fluoride	.000
				Tooth mousse	.000
				ICON	.000
			Fluoride	Tooth mousse	.000
				ICON	.000
			Tooth mousse	ICON	.210
Orange juice	203.87	.000	WSL	Fluoride	.000
				Tooth mousse	.000
				ICON	.000
			Fluoride	Tooth mousse	.140
				ICON	.000
			Tooth mousse	ICON	.000

The mean difference is significant at the 0.05 level.

DISCUSSION

WSLs and treated WSLs groups in DDW

The increased mean of lesion depth after formation of artificial WSLs was because the air or water in the micro-porosities of WSLs through

the enamel that produced the white opacity and this air or water in the micro-porosities of WSLs was replaced with fluoride ions of varnish and localization of ACP of tooth mousse treatment material leading to a state of supersaturation within the enamel and promote the remineralization and decrease of lesion depth mean values this comes in agreement with Reynolds's study [11]. The resin infiltration (ICON) might unfilled the micro-porosity in subsurface layer of WSL with resin and might stilled filled with air or water.

WSLs and treated WSLs groups in Cola

The immersion of WSLs in Cola increased the lesion depth that might be due to the erosive effect of phosphoric acid of Cola that increase of WSLs porosity and staining effect of caffeine of Cola on WSLs.

The treatment of WSLs with tooth mousse or fluoride varnish or resin infiltration (ICON) decreased the lesion depth because of the deposition of calcium ions of tooth mousse and fluoride ions of varnish that might form fluoroapatite crystals that enhanced subsurface remineralization. There was no statistically significant difference in lesion depth improvement between ICON and tooth mousse groups in Cola and this might due to the deposition of calcium ions of tooth mousse that had the same effect of resin infiltration in the porosity of subsurface layer of WSLs or the Cola drink might cause staining effect on the resin matrix of ICON. Other studies [12-16] agreed with present study that investigated the effectiveness of treatment with soft drinks.

WSLs and treated WSLs groups in orange juice

The titratable acidity and the citric acid in the orange juice might cause enhancement of discoloration and increase the permeability of the superficial WSLs surface as well as increasing the consumption of acidic drink (orange juice) which increased the lesion depth.

Treatment of WSLs with the resin infiltration (ICON), fluoride varnish and tooth mousse deceased the lesion depth with a statistically significant difference between each two groups (WSLs and treatment groups); this might be due to the deposition of calcium ions of tooth mousse and formation of fluoroapatite crystals by fluoride varnish in WSLs which gave the remineralization against the orange juice in addition the lesion depth improvement of ICON might because the resin infiltration to WSLs filled the porosities that prevent the infiltration of citric acid of juice to subsurface layer of WSLs, these results of ICON was in agreement with other studies [17,18] .

The conclusions that can be drawn from this study were:

1. The use of remineralization material (fluoride varnish, tooth mousse) could return minerals to subsurface enamel of WSLs and improve esthetics and lesion depth against soft drinks.
2. Resin infiltration could improve the esthetic characteristics of WSLs; however, the long-term effect of resin infiltration on WSLs in clinical practice should be studied further.

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الخلاصة

البقع البيضاء (WSLs) ضرر يصيب السطح تحت المينا نتيجة عملية إزالة معادن المينا مما يؤثر على جمالية مينا الأسنان، لذا كان الهدف من هذه الدراسة المختبرية تقييم عمق الأصابة للبقع البيضاء ومدى تقليلها بعد معالجتها بالفلورايد و كريم الأسنان (tooth mousse) و الراتنج (ICON) واستقرارها ضد تصبغات مشروبات الكولا او عصير البرتقال.

تم تكوين البقع البيضاء (WSLs) الاصطناعية على مينا مائة وعشرون من الضواحك العلوية البشرية باستخدام محلول لإزالة المعادن ذو الرقم الهيدروجيني (4-4.5) في درجة حرارة الغرفة . تم تقسيم العينة عشوائيا لأربع مجموعات ، تم علاج ثلاث مجموعات بالفلورايد و كريم الأسنان (tooth mousse) و الراتنج و المجموعة الرابعة بقت غير معالجة. تم وضع المجموعات في مشروب الكولا وعصير البرتقال لمدة 24 ساعة لأختبار قابلية تلوينها. تم قياس عمق البقع البيضاء بالمياكرون بواسطة المجهر المجسم وبرامج الكمبيوتربعد تقطيع العينة عند تكوين البقع البيضاء والمعالجة وبعد تغير لونها.

كشفت نتائج الدراسة عن زيادة متوسط عمق البقع البيضاء. تم الحصول على أفضل تحسين عمق البقع بواسطة الفلورايد ثم كريم الأسنان الموضعي (tooth mousse) و تليها الراتنج مع فرق معنوي كبير بين مجموعات العلاج أثناء تغير لونها في عصير الكولا وعصير البرتقال إلا بين مجموعة البقع البيضاء و الراتنج (p=0.341) في الماء المقطر و بين مجموعة كريم الأسنان (tooth mousse) و الراتنج في مشروب الكولا(p=0.2) حيث لا يوجد فرق معنوي.

يمكننا الاستنتاج ان علاج عمق البقع البيضاء بأستخدام الفلورايد او كريم الأسنان (tooth mousse) كانت مستقرة نسبيا تحت تأثيرات الكولا وعصير البرتقال. وأن الراتنج عالج عمق البقع البيضاء وأظهر على المدى الطويل انخفاضا ضد الكولا وعصير البرتقال.