Research Article

Effect of Resin Infiltration and Microabrasion on the Microhardness of the Artificial White Spot Lesions (An in Vitro Study)

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Abstract: Background: White spot lesion is the first visible sign of dental caries that is characterized by demineralized lesion underneath an intact surface. Several studies demonstrated that they could be treated using noninvasive techniques like the use of fluoride or casein phosphopeptide and amorphous calcium phosphate. Improvement in aesthetic outcomes by covering the demineralized enamel is one of the advantages of the use of resin infiltration and opalustre microabrasion, which are two new techniques that had been used for treatment of white spot lesion. The purpose of this study was to evaluate the impact of resin infiltration and microabrasion in the microhardness of the artificial white spot lesions at various depths. Material and method: Forty-eight artificially white spot lesions were divided into three groups (n=16) according to the depth of the lesion (shallow enamel, deep enamel, shallow dentine). Then, each of the main groups was divided into two subgroups (n = 8), the first group was treated with resin infiltration, while the second one was treated with Opalustre microabrasion. Assessment of the microhardness was done using Vickers hardness at the baseline, after demineralization (formation of the white spot lesion) and after the treatment with the resin infiltration and the microabrasion. Results: There was a significant difference in the microhardness of all the layers after demineralization. Although the hardness values that found among the icon group in the inner enamel and the outer dentine were higher than that of the opalustre, statistically there was no significant difference between the two materials in all the layers of the white spot lesion. Conclusion: Microhardness values decrease as the depth of the white spot lesion increase. There was an increase in the microhardness values after the treatment with the resin infiltration and the microabrasion.

Keywords: Microabrasion, Microhardness, Resin infiltration, White spot lesions.

Introduction

Increase awareness was noticed among people for the importance of the presence of a beautiful smile so they are seeking and demanding aesthetic solutions [1,2].

White spot lesions (WSLs) are white enamel patches caused by mineral loss in the enamel's subsurface layer. Incipient or enamel caries are terms used to describe these areas. They are the precursors to dental cavities, and their opaque color can result in cosmetic issues that can last many years [3].

To prevent these lesions from developing into cavities, prompt identification and treatment are required and as these lesions can be remineralized and monitored over time; early diagnosis is crucial [4].

The DIAGNOdent 2190, also known as the DIAGNOdent Pen, is a diagnostic device that emits reflected fluorescent light at 700–800 nm after pulsed laser irradiation of a carious lesion (5,6). Values between these lesions can be remineralized and monitored over time; early diagnosis is crucial [4].

The DIAGNOdent 2190, also known as the DIAGNOdent Pen, is a diagnostic device that emits reflected fluorescent light at 700–800 nm after pulsed laser irradiation of a carious lesion [5,6]. Values between 6 and 20 show enamel lesions, values between 20 and 30 suggested superficial dentinal lesions, while values over 30 indicate severe dentinal caries. Several studies looked at the reliability and the validity of the DIAGNOdent in measuring the WSLs and the smooth surface caries [7,8].

For the treatment of WSLs, various treatments have been proposed; some are conservative, like the remineralization treatment, while others are more aggressive, like bleaching [9,10]. Resin infiltration has been intensively investigated as far as more dental tissue-preserving strategy to halt and manage smooth surface or proximal lesions. The goal of this concept is the obstructing of the high porosity of an early enamel lesion using low-viscosity resins. This method genuinely adheres to the concepts of noninvasive dentistry, which aid in the detection of incipient lesions using diagnostic instruments as well as the limited invasive intervention of the cavitated lesions [11].

Furthermore, the resin-filled microporosities cannot evaporate, resulting in immediate aesthetic enhancement [12]. On the other hand, microabrasion was reported by Roberson et al. in 2002 as a conservative option for the reduction or eradication of the superficial discolorations. It has a wide range of uses, including the elimination of the surface non-carious enamel irregularities and nowadays it had been proposed as a method for removing the demineralized white lesions [13].

A paste containing hydrochloric acid and pumice is applied to the affected tooth surfaces to uniformly remove up to 0.2 μm of enamel surface using a combination of chemical erosion and mechanical abrasion. Microabrasion produces a glossy, glass-like enamel surface that may refract and reflect light in a number of ways [14,15]. Any remaining underlying enamel stains may be concealed by these optical qualities, Saliva hydration of the teeth improves these favorable optical properties [10].

Microhardness testing of the demineralized and the treated lesions at various depths of enamel and dentine is an effective approach for obtaining indirect information about the changes concerning the mineral content in dental hard tissues. Furthermore, no available Iraqi study had been found concerning the evaluation of the effect of the resin infiltration and the microabrasion of the artificial white spot lesions at various depths. Therefore, this study aimed to assess the surface qualities of the artificially induced white spot lesions after treatment with the resin infiltration and microabrasion in terms of the surface microhardness at various depth. The null hypothesis suggests that there is no significant difference in microhardness of Resin infiltration and Opalustre microabrasion material at various depths of demineralization.

Materials and Methods

Samples

A total of 48 sound premolars were extracted, for orthodontic demand, from patients aged 12-20 years old [16,17]. They were obtained from different private and public dental clinics in Baghdad city. Teeth with hypoplasia, crack, incipient carious lesions/white spots and filling were excluded after being checked by 10X magnifying lens. In order to eliminate the debris and soft tissues, all the teeth were washed and polished using non fluoridated type of pumice slurry (PD, Switzerland), the collected teeth were stored for one week in a 0.05 % thymol solution (an antimicrobial solution that inhibits bacterial growth). Then, the teeth soaked in deionized distilled water (DDW) until they were subjected to any intervention [18].

Sample preparation

In order to prepare flat surface for Vicker's microhardness testing, the buccal surface of each tooth was polished with Sof-Lex Disks (3M ESPE, USA) in a progressive manner (beginning with the coarse, then medium and fine, ending with the superfine) using contra-angle slow-speed hand-piece.

Then a circular opening of 6mm in diameter was standardized on the buccal surface of every tooth with a ruler. An imaginary line was drawn on the tip of the buccal cusp to the cervical line, as well as additional line among the mesial and distal tooth surfaces at their most prominent curvature, to determine the middle area of the buccal surface. Then, a 6mm adhesive tape circle was cut and put on the buccal surface of the tooth. After that, the tooth was painted with an acid resistant nail varnish after that adhesive tape was removed, leaving a circular window on the buccal surface of the tooth, following the demineralization, the specimens were properly washed in deionized distilled water (DDW) once more [19].

WSLs formation

Two hundred ml of demineralizing solution was prepared (2.2 mM potassium dihydrogen phosphate (KH2PO4), 2.2 mM calcium chloride (CaCl2), and 50 mM acetic acid) for a whole day [20].

All of the teeth were immersed in an artificial caries solution for a whole day with pH of 5 at 37°C, the solution was changed daily until the frosty white appearance was achieved. The extent of the white spot lesion was assessed on daily basis with a DIAGNOdent pen. If the extent of the lesion was not sufficient, the teeth were immersed again in the artificial caries solution [21].

The readings of the induced WSLs in the shallow enamel were ranged between 6 and 14, which assembled in about a week. While the readings of deep enamel lesion were ranged from 15 to 20 and they took about 10 days to be yield. A duration period of about 15 days was needed to induce WSLs in the shallow dentine by which their readings were ranged between 21and 29 [22].

Treatment groups after WSLs formation

The main three groups were allocated randomly into two groups, each group of 8 teeth, according to the type of treatment, which was either one of the following:

1- Resin infiltration group: Icon resin (Icon etch; DMG, Hamburg, Germany). The application of the material was done according to the manufacturer instruction as follows: Icon-etch (15%HCl gel) applied first for 2 min, followed by water rinsing and air-drying for 30s. The second step was by application of Icon-dry (ethanol) for 30s then air-drying, third was application of Icon- infiltrant for 3 min., with light curing of the infiltrant for 40 s, and then treated sample teeth stored in DDW.

2- Opalustre Microabrasion group: Opalustre was used (Opalustre Enamel Microabrasion Slurry, Ultradent, South Jordan, Utah, USA). In which also applied according to manufacture instruction, Abrasive material was applied on the surface of the teeth with mechanical friction performed by a rubber cup at 500 r/min speed, lasting 30 to 40 seconds, followed by Water rinsing and air drying.

Microhardness Testing

The Vicker's microhardness test (400 Series, Wilson Wolpert, Germany) was measured for each tooth of the total sample at the baseline, after white spot lesion formation and after treatment with each material with a diamond indenter made with a 300 g load. Three indentations (500 µm apart) were applied on the buccal surfaces, with a dwell time of 15 seconds. Indentation was noticed in digital readings, and an average was obtained[24].

Statistical analysis

The data collected was subjected to the statistical package for social science (SPSS, version 21, Chicago, Illinois, USA). Descriptive statistics as minimum, maximum, mean, standard deviation (SD) was used. The inferential statistics were Shapiro Wilk Levene test and General linear model, the Least Significant Difference (LSD) and Bonferroni post hoc test. The level of significance was set at 0.05. Partial eta square Effect size was: small (0.01-0.059), medium (0.06-0.139), Large >=0.14.

Results

Microhardness is normally distributed among phases, layers and materials using Shapiro Wilk at p>0.05. At the three different depth groups, the surface microhardness was measured at the baseline, after demineralization and after treatment with the Icon and the Opalustre, (Table 1). The surface microhardness was decreased dramatically after demineralization then it raised again after treatment. There was a significant difference in the microhardness of all the depths of WSL at the different phases of the study.

Table 1: Descriptive and statistical test of Microhardness unit (VHN) among phases and groups by layers.

Layers	Phases	Material							
		Resin infiltration				**Opalustre microabrasion**			
		Minimum	**Maximum**	**Mean**	**±SD**	**Minimum**	**Maximum**	**Mean**	**±SD**
outer Enamel	**Base line**	257.320	487.210	362.534	70.181	220.700	438.200	344.786	79.370
	Demin.	188.570	280.040	232.499	32.086	126.500	299.700	233.058	58.228
	After treatment	227.600	378.600	315.663	53.721	201.300	393.700	319.428	76.692
Statistics	**F**	25.820				20.711			
	P value	0.00000*				0.00000*			
Inner Enamel	**Base line**	235.060	428.100	344.924	64.885	272.700	473.500	336.810	61.475
	Demin.	125.700	238.300	187.476	32.001	143.600	239.700	187.995	28.312
	After treatment	217.400	398.500	298.858	70.708	236.400	361.500	284.416	39.563
Statistics	**F**	38.810				33.851			
	P value	0.00000*				0.00000*			
Outer Dentine	**Base line**	275.600	407.280	339.549	52.426	242.470	453.160	348.296	60.608
	Demin.	128.700	238.300	174.161	32.798	156.280	210.900	179.724	17.978
	After treatment	256.220	360.760	299.648	40.197	205.680	349.600	279.584	50.466
Statistics	**F**	44.695				43.619			
	P value	0.00000*				0.00000*			

***=significant at p≤0.05.**

While there was a decrease in the hardness in all depth layers after demineralization, a noticeable increase was found after treatment with each of the materials. However, when comparing the effect size between the two materials (icon and the opalustre), it was slightly higher for the icon material than it was for the opalustre, which mean that the resin infiltration was the better in improving the microhardness of teeth after demineralization than the microabrasion.

Pairwise comparison in Table2 shows a statistical significant difference between each phase of the study in all the depth layers and for both of the materials except in outer enamel layer in opalustre material between baseline and after treatment, the result was not significant.

Table 2: *Multiple comparisons of microhardness unit (VHN) between different study phases according to lesion depth and study materials.*

Pairwise Comparisons

Measure: VH

Material	Layer	(I) study phase	(J) study phase	Mean Difference (I-J)	p- value
Resin infiltration	outer Enamel	Base line	Demineralization.	130.035	0.00000 *
			After treatment	46.871	0.00032 *
		Demineralization.	After treatment	-83.164	0.00000 *
	Inner Enamel	Base line	Demineralization.	157.448	0.00000 *
			After treatment	46.066	0.00040 *
		Demineralization.	After treatment	-111.381	0.00000*
	Outer Dentine	Base line	Demineralization.	165.388	0.00000*
			After treatment	39.901	0.00221*
		Demineralization.	After treatment	-125.486	0.00000*
Opalustre micro-abrasion	outer Enamel	Base line	Demin.	111.729	0.00000*
			After treatment	25.359	0.07673 ^
		Demin.	After treatment	-86.370	0.00000*
	Inner Enamel	Base line	Demin.	148.815	0.00000*
			After treatment	52.394	0.00006*
		Demin.	After treatment	-96.421	0.00000*
	Outer Dentine	Base line	Demin.	168.573	0.00000*
			After treatment	68.713	0.00000*
		Demin.	After treatment	-99.860	0.00000*

b. Adjustment for multiple comparisons: Bonferroni.

***=significant at p≤0.05, ^ not significant.**

Discussion

Dental caries prevention techniques primarily attempt to arrest caries and to remineralize the affected dental surface in its early phases. In fact, using preventive materials to treat the initial decay and white lesions on the enamels will slow or avoid the cavity growth and maintain the tooth structure. Initial enamel lesions can be treated and their acidity resistance can be increased with specially devised treatment regimens [25]. Incipient lesions have reduced microhardness than that of the sound and caries-free enamel surface. The process of chemical dissolving of enamel rods weakens the enamel and generates voids, resulting in a loss in microhardness after demineralization [26,27].

Microhardness tests are commonly utilized to assess the tooth hardness. This procedure is simple, rapid, and only takes a small part of the sample buccal surface to test. In 2003, Gutierrez-Salazar and

Reyes-Gasga proposed in tooth hardness studies the Vicker indenter is more useful than the Knoop's, so the Vickers hardness test was chosen in this study [28].

In this study the specimen surfaces were impressed with a diamond indenter made with a 300 g load, three indentations (500 µm apart) for 15 seconds [29,30].

The microhardness of the samples treated with resin infiltration was increased. This could be explained as that because of the low viscosity, resin fills the pores between the remaining crystals in the porous lesion, forming a diffusion barrier not only on the surface, but also even within the lesion body, causing the demineralized tissues to reharden and enhance the mechanical strength. The results of this investigation agreed with those of Torres et al. [26] and Paris et al. [31], who found that resin infiltration improves the microhardness of the carious lesions when compared to the untreated artificial lesions following demineralization,

Microhardness was significantly increased when microabrasion techniques were used, indicating that this micro-invasive treatment method was beneficial for the management of incipient caries lesions. Although there were insufficient researches on the outcome of the microabrasion on enamel hardness, the procedure has previously demonstrated an increase in enamel microhardness following a microabrasion process, like the finding of vitro research by Yazkan's [32]. Hardness improvement can be explained according to the theory indicating that the acid compound changes the prismatic structure of enamel, causing a compacting effect so therefore increasing the hardness of the teeth [33,34].

In this study, when comparing the mean difference between the Icon and the opalustre materials, it was found that the mean difference of resin infiltration in the outer enamel between the demineralization and after treatment phases was lower than in opalustre material. However, the mean difference of Icon in inner enamel and outer dentine was higher than in opalustre, which mean according to this result the Icon material had a better performance in increasing the microhardness.

Conclusion

As of when the depth of the WSL increased the microhardness value decrease accordingly. Both resin infiltration and microabrasion were effective in treating WSL and improving the microhardness values of the teeth at different depth of demineralization.

Conflict of interest: None.

References

1. Tashima AY, Aldrigui JM, Bussadori SK, et al. Enamel microabrasion in pediatric dent.: case report. ConScientiae Saude. 2009; 8(1):133-8.
2. Heravi F, Ahrari F, Mahdavi M, et al. Comparative evaluation of the effect of Er: YAG laser and low level laser irradiation combined with CPP-ACPF cream on treatment of enamel caries. J Clin Exp Dent. 2014;6(2):e121.
3. Poosti M, Ahrari F, Moosavi H, et al. The effect of fractional CO 2 laser irradiation on remineralization of enamel white spot lesions. Lasers Med Sci. 2014;29(4):1349-55.
4. Abbas BA, Marzouk ES, Zaher AR. Treatment of various degrees of white spot lesions using resin infiltration—in vitro study. Prog Orthod. 2018 ;19(1):1-0.
5. Kühnisch J, Bücher K, Henschel V, et al. Reproducibility of DIAGNOdent 2095 and DIAGNOdent Pen measurements: results from an in vitro study on occlusal sites. Eur J Oral Sci. 2007 ;115(3):206-11.
6. Lussi A, Hibst R, Paulus R. DIAGNOdent: an optical method for caries detection. J Dent Res. 2004 ;83(1_suppl):80-3.
7. Giray FE, Durhan MA, Haznedaroglu E, et al. Resin infiltration technique and fluoride varnish on white spot lesions in children: Preliminary findings of a randomized clinical trial. Niger J Clin Pract. 2018;21(12):1564-9.
8. Moriyama CM, Rodrigues JA, Lussi A, et al. Effectiveness of fluorescence-based methods to detect in situ demineralization and remineralization on smooth surfaces. Caries Res. 2014;48(6):507-14.

9. Savas S, Kavrìk F, Kucukyilmaz E. Evaluation of the remineralization capacity of CPP-ACP containing fluoride varnish by different quantitative methods. J Appl Oral Sci. 2016; 24:198-203.
10. Ebrahimi M, Mehrabkhani M, Ahrari F, et al. The effects of three remineralizing agents on regression of white spot lesions in children: A two-week, single-blind, randomized clinical trial. J Clin Exp Dent. 2017;9(5):e641.
11. Prajapati D, Nayak R, Pai D, et al. Effect of resin infiltration on artificial caries: an in vitro evaluation of resin penetration and microhardness. Int J Clin Pediatr Dent. 2017 ;10(3):250.
12. Meyer-Lueckel H, Paris S. Improved resin infiltration of natural caries lesions. J Dent Res. 2008 ;87(12):1112-6.
13. Yetkiner E, Wegehaupt F, Wiegand A, et al. Colour improvement and stability of white spot lesions following infiltration, micro-abrasion, or fluoride treatments in vitro. Eur J Orthod. 2014 ;36(5):595-602.
14. Croll TP, Helpin ML. Enamel microabrasion: a new approach. J Esthet Restor Dent. 2000 ;12(2):64-71.
15. Sundfeld RH, Croll TP, Briso AL, et al. Considerations about enamel microabrasion after 18 years. Am J Dent. 2007 ;20(2):67-72.
16. Attar IJ, Ghaib NH. The Effect of Some Remineralization Materials and Resin Infiltration (ICON) on the Depth of White Spot Lesions. J. Bagh. Coll. Dent. 2018;30(2).
17. Hussein KM, Al-Shamma AM. Effect of Staining and Brushing on the Surface Roughness of White Spot Lesions Treated with Resin Infiltration Technique. Indian J Public Health Res Dev. 2019 Oct 1;10(10).
18. Ansari MY, Agarwal DK, Gupta A, et al. Shear bond strength of ceramic brackets with different base designs: Comparative in-vitro study. JCDR. 2016 ;10(11):ZC64.
19. Bartlett DW, Coward PY. Comparison of the erosive potential of gastric juice and a carbonated drink in vitro. J Oral Rehabil. 2001 ;28(11):1045-7.
20. Jayarajan J, Janardhanam P, Jayakumar P. Efficacy of CPP-ACP and CPP-ACPF on enamel remineralization-An in vitro study using scanning electron microscope and DIAGNOdent®. Indian J Dent Res. 2011 ;22(1):77.
21. Ou XY, Zhao YH, Ci XK, et al. Masking white spots of enamel in caries lesions with a non-invasive infiltration technique in vitro. Genet Mol Res. 2014 ;13(3):6912-19.
22. Giray FE, Durhan MA, Haznedaroglu E, et al. Resin infiltration technique and fluoride varnish on white spot lesions in children: Preliminary findings of a randomized clinical trial. Niger J Clin Pract. 2018;21(12):1564-9.
23. Asl-Aminabadi N, Najafpour E, Samiei M, et al. Laser-Casein phosphopeptide effect on remineralization of early enamel lesions in primary teeth. J Clin Exp Dent. 2015 ;7(2):e261.
24. Mandava J, Reddy YS, Kantheti S, et al. Microhardness and penetration of artificial white spot lesions treated with resin or colloidal silica infiltration. JCDR. 2017 ;11(4): ZC142.
25. Esfahani KS, Mazaheri R, Pishevar L. Effects of treatment with various remineralizing agents on the microhardness of demineralized enamel surface. J Dent Res Dent Clin Dent Prospects. 2015;9(4):239.
26. Son JH, Hur B, Kim HC, et al. Management of white spots: resin infiltration technique and microabrasion. J Korean Acad Conserv Dent. 2011 ;36(1):66-71.
27. Torres CR, Rosa PC, Ferreira NS, et al. Effect of caries infiltration technique and fluoride therapy on microhardness of enamel carious lesions. Oper dent. 2012;37(4):363-9.
28. Gutiérrez-Salazar MD, Reyes-Gasga J. Microhardness and chemical composition of human tooth. Materials Research. 2003; 6:367-73.
29. Chuenarrom C, Benjakul P, Daosodsai P. Effect of indentation load and time on knoop and vickers microhardness tests for enamel and dentin. Mater. Res. 2009; 12:473-6.
30. Toledano M, Osorio R, Osorio E, et al. Microhardness of acid-treated and resin infiltrated human dentine. J. of dent. 2005 ;33(4):349-54.
31. Paris S, Schwendicke F, Seddig S, Müller WD, et al. Micro-hardness and mineral loss of enamel lesions after infiltration with various resins: influence of infiltrant composition and application frequency in vitro. J of dent. 2013 ;41(6):543-8.
32. Yazkan B, Ermis RB. Effect of resin infiltration and microabrasion on the microhardness, surface roughness and morphology of incipient carious lesions. Acta Odontol Scand. 2018 ;76(7):473-81.
33. Dos Santos Bertoldo CE, Pini NI, de Azevedo Miranda D, et al. Physicochemical properties of enamel after microabrasion technique. J of Res. in Dent. 2014;2(2):176-88.
34. Fragoso LS, Lima DA, De Alexandre RS, et al. Evaluation of physical properties of enamel after microabrasion, polishing, and storage in artificial saliva. Biomed Mater. 2011;6(3):035001.

العنوان: تأثير الراتنج والكشط الدقيق على الصلادة الدقيقة لآفات البقع البيضاء الاصطناعية (دراسة في المختبر)

الباحثون: ريم مجيد المعموري1 , اسيل حيدر الحيدر 2

المستخلص:

الخلفية: البقع البيضاء هي من اول علامات ظهور التسوس في الاسنان وتكون هذه البقع منزوعة المعادن أسفل السطح السليم. اسبابها متعددة قد تظهر بسبب تراكم الصفيحة الجرثومية والبكتريا التي تطورت لدى الأطفال والمراهقين الصغار الذين يعانون من سوء نظافة الفم. الهدف من الدراسة هو اختبار ومقارنة الصلادة بين مادة الراتنج والقشط الدقيق في الاعماق المختلفة للبقع البيضاء.

المواد وطرق العمل: تم تكوين البقع البيضاء على 48 سن من الضواحك البشرية باستخدام محلول ازالة المعادن ثم تم تقسيم الاسنان الى ثلاث مجاميع اساسية تبعا لعمق البقع البيضاء باستخدام قلم ال **diagnodent**. ثم تم تقسيم كل مجموعة الى مجموعتين حسب نوع العلاج (مادة الراتنج اوالقشط الدقيق).

النتائج: يمكننا الاستنتاج ان كلما زاد عمق البقع البيضاء قلت صلادة الاسنان في حين كان هناك زيادة في صلادة الاسنان بعد معالجتها بمادة الراتنج والقشط الدقيق.

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