Assessement of White Spot Treated with (ICON) and Flouride Gel (An In Vitro Study)

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Abstract

Aims: The purpose of this study was to evaluate the microhardness (MH) and surface roughness (SR) of the artificially demineralized enamel treated with resin infiltration system (ICON) and fluoride gel.

Materials and Methods: One hundred twelve sound human premolars were used in this study. The root discarded and crowns sectioned in mesiodistal direction to yield two pieces. Buccal and lingual halves were used in the study. Specimens were mounted in acrylic and polished to obtain smooth and flat enamel surface, specimens were divided into 4 groups [28 teeth in each (28 buccal and 28 lingual)] as follows: (A) control negative, (B) NaF, (C) ICON, and (D) control positive. Specimens in all groups except D were demineralized with a buffered demineralization solution for 5 days. Following demineralization. The MH of the specimens was evaluated using Vicker microhardness testing machine and SR of specimens was evaluated using Profilometer. The data analyzed statistically using one way ANOVA and Duncan test (p≤ 0.05).

Results: ICON and control positive exhibited significant MH than NaF gel and control negative. Also results show that NaF gel and ICON had MH significantly higher than control negative. Also there was a significant difference between ICON and control positive.

Conclusions: The findings of the current study proved the benefits of ICON in enhancing the microhardness and decrease surface roughness of the demineralized enamel more than NaF gel.

Key words: Microhardness, Surface Roughness, ICON, NaF gel, Demineralized enamel.

INTRODUCTION

Dental caries is the localized destruction of susceptible dental hard tissues by acidic by-products of bacterial fermentation of dietary carbohydrates.¹,² The white spot lesion is the first visible evidence of caries in the enamel.³ The common treatment strategy for this white spot comprises topical application of fluorides and improvement of oral hygiene to achieve remineralization of the demineralized enamel.⁴⁻⁶ The underlying lesion body is still porous, however, and thus the whitish appearance often persists.⁷⁻⁹ Moreover, during remineralization stains can be incorporated into the lesion, leading to the formation of brown spots,¹⁰ a situation that might be judged as even more not aesthetically. Caries infiltration is an alternative therapeutic approach to prevent further progression of enamel lesions. This treatment aims to occlude the microporosities within the lesion body by infiltration with low-viscosity light-curing resins that have been optimized for rapid penetration into the porous enamel (infiltrants).¹⁰⁻¹² This procedure does not need prior temporary tooth separation and therefore, it requires only one visit.¹³

MATERIALS AND METHODS

Samples Preparation:

One hundred twelve sound human maxillary premolars extracted for orthodontic purpose were collected; all teeth were stored in deionized water after extraction at 37°C until their use. The roots discarded, and crowns sectioned longitudinally into two pieces (buccal and lingual), in the mesiodistal direction using disk bur. Then, the buccal portion of the specimens was embedded in acrylic resin with outer buccal and lingual surface exposed. The enamel surfaces were ground wet using 600-2000 grit silicon carbide abrasive paper to expose standardized flat enamel surfaces for microhardness. Each specimen was then coated under a digital stereomicroscope (X 40) with two layers of acid resistance nail varnish, leaving a 3×3mm window on the middle third of the enamel surface.¹⁰,¹¹,¹² After that, specimens randomly divided into 4 groups with 56 specimens in each group (28 buccal and 28 lingual) as follows:
Group A: Specimens were demineralized and stored in deionized water (control negative).

Group B: Similar to group C, but the treatment agent was topical natural NaF gel (containing Water, phosphoric acid (<3 %), flavors and scents, additives and Sodium fluoride 2.72 % corresponds to 1.23 % fluoride ions) and stored in deionized water.

Group C: Specimens were demineralized and then treated with ICON (Icon-Etch: hydrochloric acid, pyrogenic silicic acid, surface-active substance Icon dry: 99% ethanol, Icon-infiltrant: methacrylate-based resin matrix, initiators, additives) and stored in deionized water.

Group D: Specimens stored in deionized water (sound) (control positive).

Demineralization procedure:

Specimen before storage and treatment (in all groups except group D) was individually suspended demineralizing solution for 5 days at a temperature of 37°C to create caries like lesions. The demineralized solution contained (2.2 mmol/L CaCl2, 2.2 mmol/L NaH2PO4 and 50 mmol/L acetic acid adjusted to pH 4.5 with NaOH). The pH values of demineralization solution were measured every day using pH meter (HI 8014, HANNA instruments, Bioblock Scientific, Illkirch, France), and the demineralized solution were replaced every day.\(^{(10,11,13)}\)

Treatment Procedures:

The protocol for Icon technique: A 15% hydrochloric gel was used to remove the "pseudo intact" surface and open the pore system of the incipient lesion body (Icon - Etch, 2 minutes). Washed (30 second), air-dried (30 second) After rinsing the area was dried with ethanol (Icon Dry 30 seconds) followed by dry air (30 second). Then, the infiltrate was applied and allowed to penetrate the lesion pores by capillary action for 3 minutes. Any excess material was removed with dental floss, and the infiltrate was light cured from three angles for 40 seconds. A second layer of infiltrate was applied for 1 minute, and light cured for 40 seconds. Treatment procedure NAF gel consisted of 1 minute application of treatment agent with the aid of the cotton tip after dry tooth surface then rinses thoroughly with deionized water for 1 minute. This procedure was performed once a day for about 5 days.

After treatment, the specimens were stored at 37°C in the artificial saliva. While the group that was not subject to treatment as in group A left in deionized water at 37°C for 2 weeks. deionized water was replaced every day, and its pH value was measured every day using a digital pH meter (J, Morita Corporation, Japan).\(^{(14)}\)

Microhardness Assessment:

The surface microhardness (SMH) of the specimens was determined using a Vickers microhardness testing machine (OLPERT, Germany) as shown in figure (1, A) with a Vickers diamond indenter and scaled microscope (ZEISS, Germany) as shown in Figure (1, B). A load of 200 g was applied to the surface of the specimens for 15 seconds. Three indentations were equally placed over a circle of 1 mm diameter at the middle third of the specimens. The diagonal length of the indentations was measured by scaling microscope (20 X lens) and Vickers values converted into microhardness values. MH was obtained using the following equation: \(HV=1.854 P/d\) where \(HV\) is a Vickers hardness in Kgf/mm² (Mpa), \(P\) is the load in Kgf and \(d\) is the length of the diagonal in mm.\(^{(10,15)}\)

Surface Roughness Assessment:

A perfilometer (Surf-Corder mod. 1700, Kosaka, Tokyo, Japan) was used to measure the initial surface roughness for specimens in all groups, with magnification of x20 as shown in figure (2). Recommends cutoffs 0.8mm. Surface roughness was characterized by the arithmetical average of surface peak and valley heights found within a central line along the area assessed (Ry), in micrometers (µm).\(^{(16)}\) Maximum peak (Ry) that was used in this study of measurement which include: A section of standard length is sampled from the mean line on the roughness chart. The distance between the peaks and valleys of the sampled line is measured in the y direction. The value is expressed in micrometer (µm) as shown in figure (3).\(^{(17)}\)

Statistical Analysis:

One way analysis of variance and Duncan tests (P≤0.05) were performed to evaluate the differences on Microhardness and surface roughness among tested groups.
RESULTS

One way analysis of variance demonstrated significant differences on the surface Microhardness SMH and surface roughness SR among tested groups as shown in Tables (1) and (2). Duncan test revealed that Microhardness and surface roughness for control positive group, ICON group and fluoride group, significantly different from each other and the results of all three previous groups were significantly higher than that of control negative group as shown in Figure (4) and (5).

DISCUSSION

One of the most recent methods for conservative therapy of incipient caries is represented by local application of sealing agents with the role of infiltrating hard dental tissues. (18, 19, 20)

In the present study, VHN values of the infiltrate group were significantly higher than those of the fluoride group. Similar results were found by Pancu et al. (21) who found that caries infiltration leads to an increased hardness of infiltrating lesions compared to the flour group.

Caries infiltration works by capillary action, whereas sealants only cover incipient caries lesions on the surface of the tooth. With this technique, the unique low viscosity resin is drawn deep into the pore system of a lesion like a sponge draws up liquid. The resin completely fills the pores within the tooth, replacing lost tooth structure and stopping caries progression by blocking further introduction of any nutrients into the pore system. (22) Icon infiltrant is a methacrylate-based resin matrix containing BisGMA and TEGDMA, This composition might explain the change in surface hardness readings between the materials. Hydrochloric acid gel erodes the surface layer. Use of longer acid conditioning with Icon (2 minutes with hydrochloric acid) could have led to deeper resin penetration. (23) Icon-dry (which contains 99% ethanol) was applied for 30 second prior to application of the infiltrant. Addition of ethanol increases the penetration coefficient by decreasing the viscosity and contact angle. (24)

Surface roughness values of the infiltrant group were significantly lower than those in the fluoride group but higher than those of the sound group. This result is in disagreement with Burgess and Cakir (2009), (25) whose found that caries infiltration did not lead to an increased surface roughness of infiltrated lesions compared to sound. Infiltrant applied to the enamel surface had sealed the enamel porosities and the resulting product appeared smoother surface than those of the fluoride group but not more than sound group. The Icon method is simple to use and avoid the sacrifice of healthy tissue. The Icon method is micro invasive because of the removal of external intact enamel layers to favor better penetration of infiltrating resin.

CONCLUSIONS

Within the limitations of the study, it can be concluded that the microhardness of the enamel surface treated with Icon was approximately less than that of sound enamel group but more than fluoride group. The treated enamel showed a clinically acceptable surface roughness, indicating that this infiltrant might be suitable for the treatment of enamel subsurface lesions. Enamel surface roughness treated with fluoride gel showed significantly higher values than those treated with resin infiltrant.

REFERENCES


(A) (B)

Figure (1): (A): Specimen fixed on the Vickers microhardness testing machine. (B): Specimen fixed on scaled microscope.

Figure (2): Specimen fixed on perfilometer
Figure (3): Maximum peak (Ry) measurement

Table (1): One way analysis of variance of the differences on microhardness among tested groups (buccal surface)

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F-value</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>246202.493</td>
<td>3</td>
<td>82067.464</td>
<td>3002.614</td>
<td>0.000*</td>
</tr>
<tr>
<td>Within groups</td>
<td>2951.857</td>
<td>108</td>
<td>27.332</td>
<td></td>
<td></td>
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<td>Total</td>
<td>249154.350</td>
<td>111</td>
<td></td>
<td></td>
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</tbody>
</table>

*Significant difference existed at p ≤ 0.05

Figure (4): Descriptive statistics and Duncan’s multiple range test of indentation hardness for comparison of buccal section for each four group, the different letters mean significant differences at p < 0.05

Table (2): One way analysis of variance of the differences in surface roughness among tested groups (buccal surface).

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F-value</th>
<th>P-value</th>
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<tbody>
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<td>Between groups</td>
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<td>39.906</td>
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<tr>
<td>Total</td>
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<td>111</td>
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</tbody>
</table>

*Significant difference existed at p ≤ 0.05
Figure (5): Descriptive statistics and Duncan’s multiple range test of surface roughness comparison of buccal section for each four groups, the difference letters means significant difference at $P \leq 0.05$