INTRODUCTION

In modern dentistry, it has been widely accepted that no cavity design or restorative material will cure caries. The term White Spot Lesion (WSL) was defined as the first sign of caries like lesion on enamel that can be detected with the naked eye. White Spot Lesion (WSL) has also been defined as subsurface enamel porosity from carious demineralization that presents itself as a milky white opacity when located on smooth surface. The common treatment strategy for white spot lesions comprises restorative procedures, improvement of remineralization using CCP-ACP containing or fluoride content diet. The first line of treatment of white spot is remineralization. The use of caries-like products, micro abrasion, conventional bonding and various types of veneers. Noninvasive treatment options should be preferred if they lower the long term caries risk by influencing etiological factors and promote the natural repair process of teeth. DMG

COMPARATIVE EVALUATION OF SURFACE ROUGHNESS CAUSED BY BEVERAGES ON WHITE SPOT LESION TREATED WITH RESIN INFILTRATE: AN IN VITRO STUDY.

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ABSTRACT

Purpose: To compare and evaluate the surface roughness caused by beverages on artificial white spot lesion treated by Resin Infiltrate.

Method: Fifteen caries-free human maxillary permanent central incisor teeth were selected and the samples were made to an enamel block of 4x4x2mm and embedded in acrylic blocks leaving the enamel surface exposed and all the samples were immersed in the demineralizing solution for 4 days to create artificial white spot lesions and the application of ICON-DMG Resin infiltrate was done. Five samples of each were divided into three study groups according to immersion solution, Group I Control-immersed in artificial saliva; Group II-Non carbonated, Group III-Carbonated, immersion procedure was performed 5 secs for 100 cys for 10days. Atomic Force Microscope was used to measure the surface roughness.

Result: Results revealed that Group I showed a mean surface roughness of 25.62 (Control), Group II showed a mean surface roughness of 32.15 nm (Non-carbonated), Group III showed a mean surface roughness of 42.60 nm (Carbonated). Conclusion: Surface roughness was found in resin infiltrate immersed in both Non-carbonated and Carbonated drinks. Among the beverages, surface roughness of resin infiltrate was found to be higher in carbonated drink than the Non-Carbonated drink.

INTRODUCTION

White spots may also be seen after removal of orthodontic bands and brackets and heavy plaque accumulation, inadequate oral home care routines and a high sugar or acid content diet. The first line of treatment of white spot is remineralization. There are creams, pastes and topical remineralization treatments such as fluoride therapy, casein phosphopeptide amorphous calcium phosphate pastes, novamin (calcium sodium phosphosilicate), invasive approaches such as micro abrasion, conventional bonding and various types of veneers. Noninvasive treatment options should be preferred if they lower the long term caries risk by influencing etiological factors and promote the natural repair process of teeth. DMG

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ICON Resin is a new micro invasive technology that will fill, reinforce, stop the caries progression and mask the enamel white spot lesions without drilling or sacrificing healthy tooth structure.\(^{[4][5][1]}\)

It has also been shown to inhibit caries progression in lesions that are too advanced for fluoride therapy. Caries infiltration involves the use of low-viscosity light curing resins composed of tri ethylene glycol di methacrylate (TEGDMA) which completely fills pores within the tooth, replacing lost tooth structure and stopping caries progression. It penetrates into the lesion by capillary forces and creates a diffusion barrier inside the lesion and not only on the lesion surface. The use of 15\% hydrochloric acid for etching the surface layer is effective and postulated to be beneficial for a deeper infiltration of the resin into the body of the lesion.\(^{[5][1]}\) The use of solvents such as ethanol, acetone and water in resin infiltrates show lower surface tension and viscosities compared with materials without solvents. These materials show higher penetration coefficient and efficacy of low viscosity “caries infiltrate”. The advantage of resin infiltration is that enamel lesions lose their whitish appearance when their micro porosities are filled with the resin and look similar to sound enamel.\(^{[1]}\)

A thorough finishing of the infiltrated surfaces is important for a good long-term prognosis of the treated teeth because the remaining roughness would facilitate plaque accumulation and thereby promote demineralization or the development of secondary carious lesions.\(^{[5]}\) Consumption behavior plays a major role in oral health. Dental erosion is defined as the pathologic, chronic loss of enamel and/or dentine resulting from chemical removal of the tooth surface, excluding tooth loss associated with bacterial produced acid.\(^{[6]}\) Dental erosion does not only affect enamel, when reaching dentine it can cause hypersensitivity, or in severe cases, pulp exposure and even tooth fracture clinical performance of filling materials are affected by erosion as well.\(^{[7]}\)

Surface roughness is an important characteristic of dental materials. Materials with roughened surfaces enhance bacterial adhesion having a higher free surface energy. In addition to promoting plaque adherence, roughened materials also suffer from increased staining. Wear of both the restorative material itself and either adjacent enamel or other materials are increased with roughness.\(^{[8]}\)

In the past, many studies have been conducted on the effects of beverages on different restorative materials. As the resin infiltrate (DMG, ICON) is a new micro invasive technology for treating white spot lesion, there is a paucity of studies in the literature regarding the effect of beverages on the surface morphology of resin infiltrate. Hence the present in-vitro study was aimed to evaluate and compare the changes in surface roughness of resin infiltrate material caused by carbonated and non-carbonated beverages on the enamel surface with artificial white spot lesion treated by Resin Infiltrate.
Geeta K, et al., Comparative Evaluation of Surface Roughness Caused by Beverages on White Spotlesion Treated with Resin Infiltrate: An- In Vitro Study.

Figure 4 Surface Roughness of Carbonated Group Shown In Three Dimensional Topography Measured By Atomic Force Microscope

Inter Comparison Of All The Three Groups (Control, Non Carbonated,Carbonated Groups) Using Students T-Test

Graph 1 On inter comparison of all the three groups the mean surface roughness by students- t test the association was found to be statistically significant (p=0.001)

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>F-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5</td>
<td>25.62</td>
<td>7.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non carbonate</td>
<td>5</td>
<td>32.15</td>
<td>8.10</td>
<td>5.17</td>
<td>0.05 S</td>
</tr>
<tr>
<td>Carbonated</td>
<td>5</td>
<td>42.60</td>
<td>8.21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S - Significant

MATERIALS AND METHODS

Fifteen caries-free human maxillary permanent central incisor teeth that had been extracted for periodontal reasons were selected for the present study. Teeth with cracks, restorations, or developmental lesions were excluded from the current study. All the teeth were stored in 0.02% thymol solution until the study was conducted on the day of study, the teeth samples removed from the solution, were thoroughly cleaned using slurry pumice with a prophylaxis brush mounted on a contra-angled hand piece. Then the samples were washed and dried for use. The roots of all the teeth samples were cut and the crowns were sectioned longitudinally in a mesio-distal direction and the samples were made to an enamel block of 4mm x 4mm x 2mm of size. Then the crown sections were embedded in acrylic resin blocks leaving the enamel surface exposed.

A demineralizing solution was prepared (2.2 mM Calcium Chloride, 2.2 mM Monopotassium Phosphate, 0.05 mM acetic acid having pH adjusted to 4.4 and 1M Potassium hydroxide) and all the samples were immersed in this demineralizing solution for 4 days to create artificial white spot lesions. After 4 days, the teeth were removed from the solution and the demineralized window of enamel was infiltrated with the low viscosity resin (ICON, DMG, Hambergh, Germany) as per the manufacturer’s instructions. The samples were immersed in artificial saliva for 24hours at 37°C and were divided into three study groups of Control, Non-carbonated, Carbonated groups consisting of five samples in each group.

In the present study, stimulation of oral environment while drinking beverages was done with alternative immersion of the sample in artificial saliva and beverages for 5 seconds for 100 cycles for 10days as shown in Figure 1. Immersion procedure was carried out twice a day for 10 days stimulating a child person drinking two beverages for 10 days. The pH of all the 3 media was measured using pH tester, before and after immersion procedure.

All 15 samples were randomly divided into three equal groups (Group I, II, III) consisting of 5 samples each into three study groups according to immersion solution, Group: I Control group -immersed in artificial saliva (pH 6.9), Group: II- Non carbonated (pH 3.4) Group: III-Carbonated (pH 2.6).After the completion of the procedure, the specimens were stored in artificial saliva and measured for surface roughness. The evaluation of surface roughness was done under Atomic Force Microscope (Agilent AFM model 5500 series), which is one of the most reliable profilometric test was used to measure the surface roughness of all the groups. The RMS roughness of these surface areas was determined as shown in Figures 2,3,4 and the mean and standard deviation were calculated from these values.

RESULTS

The Ra mean readings were recorded and statistical analysis was performed with the SPSS program version 16 at a significance level of p<0.05. One-way analysis of variance (ANOVA) was used to test, the significant differences between the 3 groups and inter group comparison was done with Student-t test. The mean values Ra and the standard deviation...
(SD) of all groups (Table1) were presented as follows: GROUP I: Control group showed a mean surface roughness of 25.62 nm with a standard deviation of 7.31. GROUP II: Non-carbonated group showed a mean surface roughness of 32.15 nm with a standard deviation of 8.10. GROUP III: Carbonated group showed a mean surface roughness of 42.60 nm with a standard deviation of 8.21. The results of inter-group comparison by ANOVA test (Graph 1) revealed that there was a statistically significant difference in surface roughness among all the groups.

**DISCUSSION**

The life span of the restoration depends on the surface texture of tooth colored restorative materials. So, the presence of irregularities on the surface of materials may influence the appearance, plaque retention, surface discoloration and gingival irritation. Materials with roughened surfaces enhance bacterial adhesion, having a higher free surface energy. Dental erosion is defined as the pathologic, chronic loss of enamel and / or dentine resulting from chemical removal of the tooth surface, excluding tooth loss associated with bacterial produced acid. Dental erosion affect enamel, when reaching dentine it can cause hyper sensitivity, or in severe cases, pulp exposure and even tooth fracture, clinical performance of filling materials are affected by erosion as well. Surface erosion, wear and abrasion can be defined as the loss of material from a surface caused by a mechanical action or through a combination of chemical and mechanical actions.

Therefore, to ensure a good long-term prognosis of the treated teeth a high quality treated surface should be an essential requirement. The term high quality surface refers to a restoration surface with low roughness, anatomical contour and restoration without excess of material, which should prevent the formation of discolouring films, avoid plaque accumulation, reduce wear rate, and enhance fracture resistance.

The critical mean surface roughness (Ra) value for bacterial colonization of various dental materials has been considered to be 0.2 µm. Surface roughness more than the critical roughness value is likely to cause significant increased bacterial adhesion, dental plaque build-up and acids to act on the dental material surface.

The term white spot lesion was defined as “the first sign of caries like lesion on enamel that can be detected with the naked eye. It has also been defined as “subsurface enamel porosity from carious demineralization” that present itself as “a milky white opacity when located on smooth surfaces”. The infiltration technique of incipient enamel lesions with resin materials of low viscosity could be an alternative approach to the widely used treatment concepts of remineralization or restorative treatment.

A new minimally invasive technique for treating white spot lesions is by caries infiltration, a product of “DMG” called “ICON”. This low viscosity resin infiltrate was used to occlude the pores within the hypomineralised lesion which act as diffusion pathways for acids and dissolved minerals, thus sealing these pathways. Thus the caries infiltration can also be used to camouflage aesthetically disfiguring white spot lesions on buccal surfaces.

Therefore, the objective of this study was to evaluate the surface roughness, using Atomic Force Microscope, of resin infiltrate, in order to establish if non-carbonated and carbonated drinks is able to modify the surface roughness of resin infiltrate (ICON DMG- smooth type).

In the present study, the sample teeth selection was similar to the study done by Priya Subramaniam (2014). Fifteen non carious human permanent maxillary central incisors extracted because of periodontally weakened teeth were selected. All the teeth were collected and stored in thymol solution until the study was conducted. This method was similar to the study conducted by Priya Subramaniam (2014). The crown portion was made into an enamel block of 4 mm x 4 mm x 2 mm size using a diamond cutting saw with profuse water irrigation. The enamel blocks were embedded in acrylic resin blocks leaving the enamel surface exposed as done by Nadia. M. Taher (2013).

The immersion procedure, in the present study was similar to that of Wongkhantee (2006), where the samples were immersed alternatively in artificial saliva and in beverages for 5 seconds for 100 cycles for 10 days. Immersion procedure was carried out twice a day for 10 days, simulating that a person drinking two beverages per day for 10 days.

In the present study, specimens were stored in artificial saliva rather than distilled water. This is because more filler materials were leached in artificial saliva than in distilled water. These findings may suggest that the oral environment is likely to cause more pronounced filler degradation. The filler leaching found in artificial saliva supports the hypothesis that an ion exchange mechanism occurs at the filler surface as reported by Soderholm K.J.M (1996).

Wongkhantee (2006) stated that the impact of beverages on the properties of resins may be directly related to the amount and frequency of their intake. Moreover, the effects of the beverages, on the resin materials may vary in strength, depending on the intrinsic features of the resin materials, such as the chemical composition, or external features, such as finishing and polishing of the restoration. In the present study, the pH of all the 3 groups was measured using pH tester, before and after immersion procedure. After the completion of the procedure, the specimens were stored in artificial saliva and measured for surface roughness.

Since the increase in surface roughness in various restorations on exposure to carbonated and non-carbonated drinks had been established by previous studies, it was decided to determine its effect on resin infiltrate in the present study.

In the present study, the values were obtained by Atomic Force Microscope. Despite the variety of available in-vitro tests for measuring surface changes, the most common form of reporting Ra within dental studies has been the surface profile Ra average (Ra, arithmetic average) or the root mean square (Rq, geometric average). Roughness is a measure of surface texture. It is often quantified by the deviations of the surface from its ideal form. If the deviations are large, then the surface...
In the present study, the control group showed the lowest surface roughness (Ra) value of 25.62 nm. The noncarbonated group showed the value of surface roughness of 32.15 nm. When the 3 study groups were compared, the association was found to be statistically significant (p<0.05). On comparison, surface roughness was seen in both carbonated (42.60 nm) and non-carbonated (32.15 nm) groups than control group (25.62 nm) and highest surface roughness was found in carbonated group. These results were in accordance with Alisa ad Abu Naila (2010) [21], Bandra.VV (2005) [22], Kshitij Bansal(2005).[23]

These results of surface roughness due to non-carbonated and carbonated drinks were similar to the study done by Claudio poggio (2012)[24], who investigated surface roughness of flowable resin composites eroded by acidic drinks and also similar to the study done by Michael Kichens, Barry M. Owens (2007)[25], who investigated the effect of carbonated beverages on the in-vitro erosion of dental enamel. Alisa ad Abu Naila (2010)[21]stated that the surface properties of a resin material, especially roughness may be greatly affected by the general chemical composition of the beverages, the type of acid present in their formulation, and also the potency of the individual acidic ingredients. When carbonated and non-carbonated beverages were compared, carbonated had the most degrading effect over the resin infiltrant followed by non-carbonated and control group. Surface roughness could also be detected in the control group comprising of artificial saliva. All the beverages used in the present study were acidic with carbonated being the most acidic (pH=2.6), and with non-carbonated being less acidic (pH=3.9) and with artificial saliva (pH=6.9). Thus, higher degradation that took place in carbonated group could be attributed to its lowest pH value. In the present study, surface roughness assessment was chosen because surface micro morphology would affect the property of the restorative materials. According to the results of the present study, the resin infiltrate was significantly roughened after they were subjected to the immersion regimen, which was similar to the results of Kshitij Bansal(2005).[22] Saijai Tanthanuch (2014)[26]stated that the carbonated drink is a popular soft drink with the lowest pH among the beverages in the present study. After the samples were immersed in the beverages, carbonated group showed the highest roughness value. It has been reported that a low pH in acidic food and drink induces erosive wear in materials. However, the surface roughness values of the present study was found to be greater than the values reported by M.T.Radu et al (2010)[27]on composites, using Atomic Force Microscope.

Alisa ad Abu Naila (2010)[21]stated that the surface degradation might occurred in resin material, when the filler and the matrix resin were too weakly bonded. According to Poggio et al (2012) [24], it was observed that there was a relationship between filler volume and the surface degradation of flowable resins and distribution density of fillers on the resin surface was related to the surface degradation of flowable resins. This means that the lower the filler loading, the greater was the surface degradation. It has been previously reported that the composites with less filler loading have more proneness to surface roughening on exposure to acidic beverages than those materials with higher filler loading. It was found by Nadia. M. Taher (2013) [18] that the main composition of resin infiltrate was BisGMA and TEGDMA with no filler particles. It is noted that the resin infiltrate material used in the present study does not contain a filler. The filler particles increase the strength of the restorative material which is absent in the resin infiltrate. This might be the most probable explanation on why increased surface roughness produced when exposed to acidic beverages, which was compared to previous studies done with composite resin materials.

**CONCLUSION:** Results obtained from the present study were:

1. Surface roughness was found in resin infiltrate immersed both non-carbonated and carbonated drinks.
2. Among the beverages, surface roughness of resin infiltrate was found to be higher in carbonated drink than the non-carbonated drink.

**Limitations of the present study**

1. In-vitro studies showing surface roughness is greater than the studies done in In-situ. This could be due to the absence of saliva protecting factor in artificial saliva.
2. Surface roughness of resin material, plays an important role in plaque accumulation and leading to caries progression. So further studies regarding surface protective coating over resin infiltrate needs to be explored.

**Reference**


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