SEM Evaluation Of The Effect Of Whitening Dentifrice On The Superficial Roughness Of An Esthetic Restorative Material.

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Abstract Background: The use of composite resins in dentistry is well accepted for restoring anterior and posterior teeth. The increased demand for esthetics has lead to the overzealous use of whitening dentifrices which can wear the surface of composite restorative resin.

Material method: Forty cylindrical samples (2mm x 5mm) were prepared with the micro-hybrid composite resin which were divided into four groups, each group containing ten samples (n=10). Group -1 was used as the control group and the samples in this group were stored in distilled water at room temperature during the entire study. Samples in other groups were brushed with a battery operated powered toothbrush, Oral-B Cross Action Power for 3 minutes daily for ten days using three different types of toothpastes, containing different abrasives; Group-2 (n=10) Pepsodent Whitening containing perlite/calcium carbonate abrasive; Group-3 (n=10) Colgate Whitening containing silica abrasive; Group-4(n=10) Shine n Smile tooth polish (ICPA Health Products Limited) containing aluminium oxide and dicalcium pyrophosphate as an abrasive. Samples were then observed under SEM for evaluation of surface roughness.

Result: The result showed that the maximum surface roughness was produced with Pepsodent Whitening followed by Colgate Whitening and Shine N Smile respectively.

Conclusion: Use of whitening dentifrice can cause severe wearing of composite restorative resins and thus compromise the esthetics.

Key words: Abrasives, composite resins, dentifrice, toothbrushing

INTRODUCTION:

Resin-based restoratives are increasingly being used in dentistry, and the continued development of materials have made a variety of tooth-colored composites available for clinical use. The long-term clinical service of composite fillings depends on their physical characteristics. One of the most important properties is the ability to withstand wear, as any loss of substance could result in alteration of the anatomic shape and affecting the performance of restorations. Although clinicians tend to concentrate on occlusal wear, some researchers have demonstrated that the abrasion process produced by oral hygiene methods can adversely affect the surface characteristics of restorative. Therefore, this process could interfere with both health and esthetics, as rough surfaces may predispose to biofilm accumulation and extrinsic staining. Several studies have evaluated the wear of resin based restoratives. The increasing emphasis on dental esthetics has made tooth whitening an important function of dentifrices. Thus in the last 10 years dentifrices have become more specialized and can be classified as either therapeutic or cosmetic. It is well known that dentifrices used in conjunction with toothbrushing act to reduce plaque and calculus deposits on teeth as well as assist in removing stains and discolorations. However, many commercially available dentifrices contain ingredients that may abrade and roughen the surfaces of restorations and hard tissues in the mouth. These dentifrices often contain hydrogen peroxide, carbamide peroxide, sodium bicarbonate, silica, or aluminium oxide. A number of studies have investigated the relative cleaning and abrasive effects of dentifrices both in vitro and in vivo. The purpose of this study was to investigate the surface roughness of composite resin following brushing with different whitening dentifrices.

MATERIALS AND METHODS

Three whitening dentifrice and a composite resin were used in the study. The materials used and their manufacturer are listed in Table 1.0

<table>
<thead>
<tr>
<th>Whitening dentifrice</th>
<th>Manufacturer</th>
<th>Particle type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pepsodent whitening</td>
<td>Hindustan Uniliver Limited</td>
<td>Perlite/calcium carbonate</td>
</tr>
<tr>
<td>Colgate whitening</td>
<td>Colgate Palmolive India Limited</td>
<td>Silica</td>
</tr>
<tr>
<td>Shine N Smile</td>
<td>ICPA health products limited</td>
<td>Aluminium oxide and dicalcium pyrophosphate</td>
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<tr>
<td>Prodigy</td>
<td>Kerr/Sybron</td>
<td>Micro-hybrid</td>
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</tbody>
</table>

Forty standardized samples of the composite resin (Prodigy, Kerr/Sybron, Orange, CA) were prepared in an acrylic mold of 5 mm diameter and 2 mm height. The composite resin was placed in the mold in three increments and each increment was cured for 10 seconds with a LED light curing unit (SmarLiteTM PS, DENTSPLY, De Trey GmbH, Germany) having 5W LED and average light output of more than 950 mW/cm². The last increments of the composite resin were cured against the matrix strip as the smoothest surfaces were obtained by
curing the material against the matrix strip. The samples were then divided into four groups (n=10) i.e., Group 1-4. The specimens were then stored in distilled water at room temperature for 24 hours before toothbrushing was initiated. Samples of Group-1 were kept in distilled water at room temperature, which was used as control group while the rest were subjected to toothbrushing with a battery operated powered toothbrush, Oral-B Cross Action Power (Oral-B Laboratories, Boston, MA, USA) and the whitening dentifrice slurry for period of 3 minutes per specimen per day for ten days i.e., total of 30 minutes per specimen; Group-2 (n=10) Pepsodent Whitening (Hindustan Uniliver Limited) containing perlite/calcium carbonate abrasive; Group-3 (n=10) Colgate Whitening (Colgate Palmolive India Limited) containing silica abrasive; Group-4 (n=10) Shine n Smile tooth polish (ICPA Health Products Limited) containing a combination of aluminium oxide and dicalcium pyrophosphate as an abrasive. After each toothbrushing session the samples were washed in tap water and stored in distilled water. The dentifrice slurry was prepared by mixing one of the dentifrice with distilled water at a ratio of 1:3 by weight. The powered toothbrush (Oral-B Laboratories, Boston, MA, USA) head was made of soft nylon bristles and it moved in and out 40,000 times/minutes. The brush head moved side to side 8,800 times/minute. After the completion of toothbrushing, the specimens were washed with tap water and stored again in distilled water at room temperature before they were finally observed under the SEM.

The thirty specimens subjected to toothbrushing and the control specimen were then dried with absorbent paper and observed under the SEM at 100× magnification (JSM 5600LV, Jeol Inc., Peabody, MA, USA).

RESULT

The pictures of the specimens obtained from the SEM had shown that the maximum toothbrush abrasion as evident from the wear of the surface of composite resin was seen in Group-2 which was brushed with Pepsodent Whitening (Hindustan Uniliver Limited) containing perlite/calcium carbonate as an abrasive (Figure 1b). The least surface roughness was seen in Group-4, brushed with Shine n Smile (ICPA Health Products Limited) containing a combination of aluminium oxide and dicalcium pyrophosphate as an abrasive (Figure 1d). The surface roughness observed in group-3, brushed with Colgate Whitening (Colgate Palmolive India Limited) containing silica as an abrasive, was intermediate (Figure 1c). The SEM picture of the control specimens i.e., group-1 did not show any wear of the composite surface (Figure 1a).

Figure 1. (a) Composite resin surface in control group, not subjected to toothbrushing (100x). The surface appears to be intact. (b) Composite resin surface subjected to toothbrushing with Pepsodent Whitening containing perlite/calcium carbonate as abrasive (100x). The surface is abraded from various portions. (c) Composite resin surface subjected to toothbrushing with Colgate Whitening containing silica as abrasive (100x). The surface shows abrasion at some areas of the restorations. (d) Composite resin surface subjected to toothbrushing with Shine n Smile containing a combination of aluminium oxide and dicalcium pyrophosphate as abrasive (100x). The surface abrasion is less extensive.

DISCUSSION

The surface texture of dental materials has a major influence on plaque accumulation, wear and discoloration of restorations. A smoother surface provides patient's comfort as even a change in surface roughness in the order of 0.3 µm can be detected by the tip of the tongue11. In vivo studies on the threshold surface roughness for bacterial plaque retention showed that a mean roughness above 0.2 µm was related to substantial increase in bacterial retention. In this study, the smoothest surfaces were produced by curing the material against a matrix strip which was supported by other studies.12

The incorporation of abrasives in specific dentifrices might help physically remove stain, but since all dentifrices contain abrasives, some degree of stain removal may be expected with regular products. It has been observed that toothbrushing can abrade the surface of resin composite materials with a three body wear process13. Toothbrushing can erode the softer polymer matrix, leaving the harder reinforcing particles standing higher. The major factors interfering with abrasion damage are the dentifrice and the toothbrush characteristics. The dentifrice is influenced by the abrasive type and size, and the slurry dilution, while the toothbrush depends on the number, rigidity and shape of tufts and bristles.1

In this study, powered toothbrush was used to simulate the in vivo condition so that the toothbrushing could be standardized for all samples leaving the dentifrices being the only variables. Powered toothbrushes have been consistently more effective than manual toothbrushes in clinical plaque removal studies.14 

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A new powered toothbrush prototype was included that uses a novel dual-moving bristle head design, with one oscillating and the other translating back and forth. This design feature allows a person to use this toothbrush with an optimal manual brushing technique, while gaining the cleaning advantages of all bristles in motion. Some powered toothbrushes have also been demonstrated to have whitening/stain removal efficacy when used with standard dentifrice products. Microfilled and hybrid resin composites are recommended for restorations in esthetically critical areas of the mouth. Different dentifrice formulations containing different abrasives were used to evaluate how these dentifrices could affect the surface roughness of the materials. The abrasiveness of the dentifrices should not result in excessive removal of the material. The surface roughness produced by the various dentifrices depends on the particle size and shape of the abrasive used, their hardness as well as their distribution within the dentifrice. The dentifrices can be examined for their abrasiveness by various methods like surface analyzer, scanning electron microscopy, dimensional change and mass loss, radioactive tracer techniques and reflectometry.

The SEM examination after toothbrushing showed that the maximum roughness of the composite resin was produced by dentifrice containing perlite as an abrasive (Pepsodent Whitening) (Figure 1b). The lowest surface abrasion was produced by dentifrice containing aluminium oxide and dicalcium pyrophosphate as an abrasive (Shine n Smile) (Figure 1d). It has been observed that as the abrasiveness of the dentifrice increases, the superficial stains will decrease. The larger the size of abrasive particles, the higher will be its abrasiveness. In this study it has been observed that perlite and silica are more abrasive as compared to the combination of aluminium oxide and dicalcium pyrophosphate.

CONCLUSION
By observing the results obtained from this study it can be concluded that the whitening dentifrices containing perlite/calcium carbonate and silica are more abrasive as compared to the dentifrices containing a combination of aluminium oxide and dicalcium pyrophosphate when used on resin based esthetic restorative material.

REFERENCES