EFFECT OF DIFFERENT DENTURE CLEANSERS ON SURFACE ROUGHNESS OF DENTURE BASE MATERIALS

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ABSTRACT

Background and Aim: It has been commonly believed that, denture cleansers have detrimental effects on the surface structure of denture base materials. The purpose of this study was to evaluate the effects on surface roughness of 4 different commercially available chemical cleaning agents (Polident, Corega Tabs, Fittydent, Efferdent) and sodium hypochlorite on the denture base materials.

Materials and Methods: Standard disc shaped test specimens were prepared at 10x2 mm dimensions from conventional acrylic resin and Chrome-Cobalt (Co-Cr). Before cleaning agent immersion, the surface roughness values (Ra) were measured. After the end of this period, surface measurements were made again and ΔRa values were calculated. Results were statistically analyzed.

Results: There were no significant differences found between before and after cleaning procedure that applied to acrylic specimens. When before and after surface roughness measurements were evaluated, there was statistically significant difference found only in sodium hypochlorite group that applied to Co-Cr test specimens.

Conclusions: Effervescent tablets and sodium hypochlorite solutions that have been used routinely up to this time, etched the surfaces of the samples similarly. Hypochlorites can be corrosive to metal based dentures and it can affect the surface roughness.

Key words: Denture Base Materials, Denture Cleansers, Effervescent Surface Roughness

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INTRODUCTION

In human mouth dentures as an indwelling medical device, prepare an optimal environment for adhesion and multiplication of both pathogenic and non-pathogenic organisms. The increasing use of removable dentures has caused increasing the denture related infections like stomatitis or other infections. Management of denture related infections is challenging and infected dentures generally need to be dis-infected. The removal of biofilm deposited on denture surfaces is commonly accomplished by mechanical methods. Due to patient’s lack of motor coordination, such methods may be ineffective, and thus demand alternative means such as chemical cleansing. The rate at which deposits accumulate on dentures may vary between individuals and can be affected by factors such as saliva composition, dietary intake, surface texture and porosity of the denture base material, duration for which the dentures are worn, and the denture-cleansing regimen adopted by the wearer. Several disinfectants have been suggested for the disinfection of dentures. The best disinfectant should fulfill most of the requirements of the ideal agent while not causing any kind of alteration in the structure of the dentures. Sodium hypochlorite is inexpensive, presents a broad spectrum of activity, and requires a short period of disinfection. Chau et al. observed that besides superficial disinfection of acrylic resin, 1% sodium hypochlorite was also effective in the elimination of microorganisms from the inner surface of the material after 10 minutes. Glutaraldehyde-based disinfectants are often used in dentistry. Tabs of sodium perborate and alkelen peroxide based denture cleansers are commonly used for denture cleaning and for helping mechanical hygiene. Gornitsky et al. verified the existence of antimicrobial activity of these solutions on microorganisms adhered to denture, but suggested that the use of denture cleaning agents might be controlled. McCabe et al. stated that the denture cleaning agents are complementary to denture hygiene and must be employed in association with mechanical cleaning for more effective biofilm elimination.

It is a clinical importance to determine the effect of denture cleansers on the properties of acrylic resins. Irregularities and porosities present on denture surfaces offer a favorable niche to retain stain and microbial plaque. The surface roughness is of particular clinical relevance since it can affect the biofilm formation or make its removal difficult. Microbial adherence capacity is influenced by differences in the surface of denture. A previous study reported that the roughness in prostheses’ surfaces might cause micro traumas in oral tissues, Williams and Lewis concluded that surface roughness favored colonization by the microorganisms, contributing indirectly to tissue injury. The efficacy of chemical denture cleansers dislodging food debris, biofilm, and tobacco stains from prosthetics surface has been previously reported. However, few studies have investigated the influence of prosthodontics cleansers on acrylic resin surfaces. Furthermore, there are not enough studies about the effects of denture cleaners on denture base materials as acrylic resins and metals together.

The aim of this study was to evaluate and the compare the effects of different denture cleanser agents on the surface roughness of different denture base materials. Our research hypothesizes that different denture cleanser agents have no effect on surface roughness of denture base materials.

MATERIALS AND METHODS

The chemical composition, types of disinfectants and denture resins used in this study are given in Table 1. Hundred disc shaped test specimens, 10 mm in diameter and 2 mm thick were produced from acrylic resin and Co-Cr (Figure 1). Fifty disc shaped wax patterns (Modeling Wax; Cavex, Haarlem, Holland) were prepared by using a teflon matrix. All the wax patterns were invested with a dental stone in metallic flasks. After the setting of stone, the flask halves were separated, the wax was removed, and the stone mold was cleansed. The resin was manipulated packed and pressed into the mold according to the manufacturer’s instructions. The heat polymerization method was in water at 73 °C for 90 min, followed by water at 94 °C for 30 min. All flasks were allowed to cool to room temperature before opening. After polymerization of the resin, the specimens were removed from the molds and immersed in distilled water at 37 ± 1 °C for 48 hours for residual monomer elimination. The excess resin was trimmed with a tungsten steel bur (Maxicut, Malleifer SA, Switzerland) using a handpiece at low speed. One of the surfaces was finished using 180, 220, 360 and 400 grit abrasive papers (Carbimet, Buehler, Lake Bluff, IL), and polished on a wet rag wheel with a slurry pumice, followed by calcium carbonate (Figure 1).

For fabricating Co-Cr test specimens fifty wax patterns (Sculpting wax FC, Bego, Bremen, Germany) were fabricated from a silicone mold with dimensions of 10 x 2 mm. Wax
patterns were sprued and invested in a phosphate bonded investment (Multi-Vest, Dentsply Int, York, PA). Fifty Co-Cr alloys were prepared to complete the castings. The alloys were cast with an induction casting machine (Fornax, Bego, Bremen, Germany). The complete castings were divested and the sprues were removed. Any remaining investment was carefully removed by air abrasion with 50 µm aluminum oxide ($\text{Al}_2\text{O}_3$) (Korox 50, Bego, Bremen, Germany). Metal surfaces were ground finished with a 600-grit silicon carbide abrasive paper (3M ESPE, St.Paul, USA) for 10 sec on a 300 rpm grinding machine (Buehler Metaserv, Buehler, Germany) under running water and ultrasonically cleaned for 15 min.

Table 1. The materials used in this study

<table>
<thead>
<tr>
<th>Product</th>
<th>Composition</th>
<th>Immersion Time</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meliodent</td>
<td>PMMA denture base material</td>
<td></td>
<td>Bayer Dental, Newburg, Germany</td>
</tr>
<tr>
<td>Wirobond C</td>
<td>Co-Cr alloy</td>
<td></td>
<td>Bego, Bremen, Germany</td>
</tr>
<tr>
<td>Efferdent</td>
<td>EDTA 240 dihydrate, FD&amp;C blue no.2, FD&amp;C green no.3, polytetrafluoroethylene, potassium monopersulfate, sodium bicarbonate, sodium lauryl sulfoacetate, sodium perborate monohydrate, sodium saccharin USP, sodium sulfate anhydrous, sodium tripolyphosphate, spearmint flavor</td>
<td>7 days (5 hours of soaking per day)</td>
<td>Pfizer Inc., New Jersey, USA</td>
</tr>
<tr>
<td>Polident</td>
<td>Subtilisin, citric acid, sodium carbonate, potassium peroxymonosulfate, sodium perborate monohydrate</td>
<td>7 days (5 hours of soaking per day)</td>
<td>GlaxoSmithKline, Brentford, United Kingdom</td>
</tr>
<tr>
<td>Corega Tabs</td>
<td>Sodium carbonate, potassium caroate, citric acid, sodium carbonate peroxide, sodium bicarbonate, sodium benzoate, PEG-180, sodium lauryl sulfoacetate, subtilisin, PBP, aroma, CL44090</td>
<td>7 days (5 hours of soaking per day)</td>
<td>GlaxoSmithKline, Brentford, United Kingdom</td>
</tr>
<tr>
<td>Fittydent</td>
<td>Sodium perborate, sodium bicarbonate, potassium monopersulphate, trisodium phosphate</td>
<td>7 days (5 hours of soaking per day)</td>
<td>Fittydent International Gmbh A-7423, Pinkafeld, Austria</td>
</tr>
<tr>
<td>Clorox</td>
<td>Sodium hypochlorite (%5,25)</td>
<td>7 days (5 hours of soaking per day)</td>
<td>Clorox, Oakland, CA, USA</td>
</tr>
</tbody>
</table>

Figure 1. Acrylic (Right) and Co-Cr (Left) Test Specimens
in distilled water and air dried. Finally the specimens were polished according to manufacturer recommendations. Each disc was numbered and a small depression drilled on one side using a round bur. The depression was used to indicate the side from which the measurements were to be taken. Then test specimens (metal group and the acrylic group) were randomly divided into 5 groups (n=10) and surface roughness values were measured by a profilometer (Surftest 301, Mitutoyo Corp., Kawasaki, Japan). The specimens were immersed for 1 week (5 hours per a day) at distilled water as a control group, 4 different alkaline peroxide effervescent denture cleansers (Corega Tabs, Polident, Fittydent, Efferdent) and finally sodium hypochlorite. The minimum volume of water was calculated by measuring the volume that would cover completely an upper full denture in a standard denture pot. This was found to be 200 mL.

After the immersion procedure completed, the surface roughness of each test specimens were measured again and the values were saved. The stylus moved across the specimen surface and three lines were recorded with a distance of 1 mm between each scanning line. The mean arithmetic roughness (Ra) was calculated from three lines and this value recorded as the mean roughness of the specimen. The tracing length was 2.5 mm and the cut-off value was 0.8 mm, at 0.5 mm/s. The resolution of the record data was 0.01 µm. The Ra was used to assess surface changes. The roughness values before immersion were subtracted from the values after immersion to obtain the ΔRa (roughness differences).

The ΔRa values were submitted to statistical analysis by one-way analysis of variance (ANOVA) and the Ra values of the groups before immersion and after immersion were statistically analyzed by Student-t test with the statistical program SPSS 12.0 (SPSSInc., Chicago, IL, USA). All tests were performed using a confidence level of 95% (α=.05).

RESULTS

In the acrylic resin test group surface roughness values were not statistically different for any group. In contrast in the Co-Cr specimens sodium hypochlorite increased the surface roughness values significantly (p<0.05) In Co-Cr specimens the Group Co, Group F, Group E and Group P did not increase the Ra value significantly (p>0.05). Ra values of test specimens were listed in Table 2. According to the test results for ΔRa values in acrylic resin specimens, the values were not statistically different for any test group (p>0.05). In Co-Cr test specimens Group SH showed highest ΔRa values from the other groups. The ΔRa values of the groups are listed in Table 3.

DISCUSSION

Surface roughness of acrylic resin is fundamentally important as it directly affects the oral health of tissues in direct contact with a denture. According to Quirynen and Bollen16, roughed surfaces like bridges, implant abutments and denture bases accumulate and retain more dental plaque than smooth surfaces. These authors further state that the bacteria, once joined to irregular surfaces and other stagnation sites can survive for long periods of time.17 The rough surface may protect the bacteria from natural removal forces and even those of oral hygiene methods. Ideally a surface with the lowest possible roughness is recommended to thwart microorganism retention, prevent local infections and early denture deterioration.11 Based on the results of this study, the research hypothesis was partially accepted. Immersion in effervescent tablets did not influence the surface roughness of specimens, but immersion in hypochlorite solution increased the surface roughness of Co-Cr test specimens. The chemical composition of the effervescent tablets did not affect the surface roughness values significantly.

Denture cleaning by immersion in chemical solution should not involve any physical, mechanical or chemical change in the acrylic resin. The decontamination process may result in alterations of the surface morphology and changes in the flexural strength.18 The effervescent tablets are efficient in removing biofilm and stains9, but the alkaline peroxide solution can alter the resin properties if not correctly used.19 Several studies20,25 have investigated the effects of denture cleansers on physical and mechanical properties of denture resins. The manufacturer’s recommended time of immersion disinfection ranged from 10 to 30 minutes. Prolonged immersion for 7 days provided a safety margin when complete denture was left in a sealed bag with one of the four disinfectants for a long period of time. This often occurs when the denture is returned from a dental laboratory and awaits the next patient appointment.24 Four denture cleanser and sodium hypochlorite were chosen in this study, these disinfectants are the most commonly used commercial chemical denture cleanser by immersion techniques. According to test results, the denture cleansers and sodium hypochlorite solution did not affect the surface roughness values.
did not show a significant increase in surface roughness of the specimens. Different surface roughness values in the literature can be attributed to different immersion times, test materials and application procedures. Pavarina et al.27 stated that prolonged immersion of denture teeth in water caused softening of the acrylic resin. Absorbed water has been shown to affect the surface properties of all forms of acrylic resins. Garcia et al.26 reported lower surface roughness measurements when the acrylic resin samples were immersed in commercial cleanser. In contrast Peracini et al.19 stated that a commercial cleanser significantly increased the surface roughness of heat-polymerized acrylic resin. However, in the same study the test specimens that immersed in water with Corega Tabs did not show a significant increase in surface roughness of the specimens. Different surface roughness values in the literature can be attributed to different immersion times, test materials and application procedures. Pavarina et al.27 stated that prolonged immersion of denture teeth in water caused softening of the acrylic resin. Absorbed water has been shown to affect the surface properties of all forms of acrylic resins.

Table 2. Mean Ra values and standard deviations of the test specimens.

<table>
<thead>
<tr>
<th>Ra Values (µm)</th>
<th>Acryl</th>
<th>Co-Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Polident (Group P)</td>
<td>0.034 ± 0.01</td>
<td>0.037 ± 0.01</td>
</tr>
<tr>
<td>Fittydent (Group F)</td>
<td>0.044 ± 0.01</td>
<td>0.045 ± 0.01</td>
</tr>
<tr>
<td>Efferdent (Group E)</td>
<td>0.057 ± 0.02</td>
<td>0.061 ± 0.01</td>
</tr>
<tr>
<td>Corega Tabs (Group Co)</td>
<td>0.033 ± 0.01</td>
<td>0.034 ± 0.01</td>
</tr>
<tr>
<td>Sodium Hypochlorite (Group SH)</td>
<td>0.083 ± 0.01</td>
<td>0.095 ± 0.02</td>
</tr>
</tbody>
</table>

Table 3. Mean ΔRa values and standard deviations of the test specimens.

<table>
<thead>
<tr>
<th>ΔRa Values (µm)</th>
<th>Acryl</th>
<th>Co-Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Polident (Group P)</td>
<td>0.0032 ± 0.00025 a</td>
<td>0.0027 ± 0.00017 a</td>
</tr>
<tr>
<td>Corega Tabs (Group Co)</td>
<td>0.0013 ± 0.00017 a</td>
<td>0.0032 ± 0.00018 a</td>
</tr>
<tr>
<td>Efferdent (Group E)</td>
<td>0.0042 ± 0.00019 a</td>
<td>0.0022 ± 0.00025 a</td>
</tr>
<tr>
<td>Fittydent (Group F)</td>
<td>0.0014 ± 0.00021 a</td>
<td>0.0061 ± 0.00018 ab</td>
</tr>
<tr>
<td>Sodium Hypochlorite (Group SH)</td>
<td>0.0119 ± 0.00179 a</td>
<td>0.016 ± 0.00353 b</td>
</tr>
</tbody>
</table>

* Same letter are not statistically different (P > 0.05).
of acrylic. Furthermore, the difference between the test groups can be attributed to different chemical nature of the denture cleansers. Sodium hypochlorite solution affects the ΔRa values of the test specimens. Rudd et al. reported that all the dentures were disinfected after being soaked for 5 minutes in 5.25% sodium hypochlorite. However, the higher concentration of the chemical in Rudd et al. study resulted in color and roughness changes in the surface of denture base materials. In this in vitro study, sodium hypochlorite solution increased the surface roughness values in all test specimens. Increased surface roughness values in Co-Cr test specimens can be related to metal corrosion. As Jagger et al. reported, a disadvantage is that hypochlorites can be corrosive to metal, which restricts their routine use for metal-based dentures.

Based on the previous research, Quirynen et al. claimed the surface roughness for acrylic resins to be 0.2 µm, under which no significant decrease in bacterial colonization would occur. Dramatic bacteria colonization would occur, beginning at 2 µm. Also researchers cited 0.12 µm as the characteristic of a smooth acrylic surface. In this in vitro study all the test groups showed lower values from the critical surface roughness value of 2 µm. More studies to explain the mechanism of these agents on resin roughness are needed and other effects of chemical disinfectants on physical and mechanical properties should also be considered when choosing a compatible disinfectant-resin combination.

CONCLUSION

Effervescent tablet solutions that have been used routinely up to this time, etch the surfaces of the samples similarly. The results of this study showed that the denture base materials did not reveal any clinical significant surface changes even after being immersed in effervescent tablets. Hypochlorites can be corrosive to metal, and this restricts their routine use for metal-based dentures.

REFERENCES


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