The effect of microwave disinfection on surface roughness and hardness of hot, cold acrylic resin and soft liner in different conditions

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ABSTRACT

Background: Microwave disinfection has been suggested as a method to disinfect the denture base and soft liner, however the effect of microwave heating on the surface roughness and hardness of cold cure acrylic resin, hot cure acrylic resin and soft liner have not been completely evaluated.

Materials and Methods: 90 specimens of (12x12x3) mm were made from hot cure acrylic resin and cold cure acrylic resin and soft liner and divided into two groups, the first group was tested for surface roughness by profilometer before and after the specimens were disinfected by microwave in three different groups 40% concentration nacl solution, Distil water and dry irradiation of microwave for 10 min. And the other group also 45 specimens made from the same three different material were tested for hardness by a vicker's hardness tester before and after disinfection in 40% concentration nacl solution, Distil water and dry irradiation of microwave for 10 min.

Results: Microwave disinfection for 10 minutes in different conditions 40% concentration nacl solution, Distil water and dry irradiation of microwave significantly increased the mean and SD values of surface roughness for hot acrylic resin, cold acrylic resin. And highly significant increase in mean SD values of surface roughness for soft liner materials after microwave disinfection in the three different conditions while the mean and SD values of hardness for cold, hot acrylic resin and liner materials does not significantly affected after microwave disinfection in the three conditions.

Conclusion: Disinfection by microwave irradiation in 40% concentration nacl solution, Distil water and dry irradiation of microwave for 10 minutes increase the surface roughness for all the materials been evaluated but it did not effect the hardness values of all materials been tested.

Keywords: Microwave disinfection, surface roughness, hardness, soft liner, and nacl solution. (J Bagh Coll Dentistry 2010;22(4):36-40).

INTRODUCTION

Adequate maintenance of removable prosthesis is needed for denture wearers to have an esthetic, odor free appliance and good oral health. Oral problems related to poor hygiene of dentures support the need to establish a disinfection protocol that is effective, clinical viable, inexpensive and easy to comply with. (1)

Denture base materials can be colonized and deeply infected by microorganisms. Contaminate prostheses can provide a source of cross-contamination between patient and dental personnel (2). Denture plaque is also a major factor in the etiology of denture related stomatitis. Therefore, denture disinfection has been recommended as an essential procedure for preventing cross contamination and the maintenance of a healthy oral mucosa (3).

The available disinfection methods for complete and partial dentures are still controversial because they may alter some material properties and clinical features (4). A denture disinfection method should be effective for inactivation of microorganisms without adverse effects on the denture materials (5).

Stocking the denture in disinfectant solutions such as sodium hypochlorite removed significantly contaminants. (6) However Baysan, Whiley and Paul. Reveal that in clinic use sodium hypochlorite solution may be contraindicated because of bleaching effect, corrosion and odor (7).

Now, microwave irradiation has been considered for denture sterilization and disinfection instead of chemical solutions because it requires no special storage, has no expiration date and does not induced resistance to Candida Albicans (8).

In previous studies of Pavan et al, microwave disinfection was performed in dry conditions (9), placing contaminated denture materials in water during microwave exposure are required to kill rather than inhabit yeast growth (10).

Many protocols for denture disinfection have been proposed including microwave radiation and immersion in chemical solution (11). Preliminary study demonstrated that microwave irradiation with specimens immersed in water resulted in sterilization against pathogenic microorganisms colonized on three hard relined resins (10).

This is particularly important for preventing recurrence of denture stomatitis, however, during microwave irradiation, water starts to boil after
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10 minutes, acrylic resin may undergo and increase in temperature beyond their glass transition temperature and become more flexible. (12)

Microwave energy has been shown to be an effective method to disinfect complete dentures, and it has been recommended as an adjunct to the treatment of denture stomatitis. A number of studies generally agree that the mechanical properties of denture base resins and acrylic resins artificial teeth are not adversely affected by microwave disinfection. (13)

The roughness of the acrylic resin surface is important since the adhesion of microorganisms to the surface is prerequisite for the colonization of that surface. (3) Surface irregularities increase the likelihood of microorganisms remaining on the denture surface after the prosthesis has been cleaned. (14) Another property that can influence the surface characteristics of acrylic resins is hardness, which is inductive of the ease of the finishing of a material as well as its resistance to in-service scratching during cleaning procedures. (15) During disinfection by immersion, the acrylic resins are in contact with chemicals. It has been observed that some disinfectant solution may have a softening effect on acrylic resins, reducing the surface hardness (14,16), changing in the surface hardness and roughness of denture base acrylic resins caused by different denture immersion solutions have been reported. (17,18)

The purpose of this study was to investigate the effect of microwave radiation on the hardness and roughness on hot cure acrylic, cold cure acrylic and soft liner material.

MATERIALS AND METHODS

Thirty specimens were made from hot cure acrylic resin, cold cure acrylic resin and soft liner ( vetex dental soft acyl. ) with dimension of (12x12x3) mm length x width x thickness respectively from a metal pattern instead of wax pattern preparation which needs more time and effort in its preparation and in the wax elimination procedure.

All flashes of acrylic were removed with an acrylic bur, then the pink stone bur was used to get a smooth surface for the samples and followed by sand paper of medium grit to remove any remaining small scratches then the polishing was done with bristle lathe brush (white stiff 360) and pumice by using lathe polishing machine. After polishing all specimens were stored in distilled water at 37c for 24hr to get rid of residual monomer.

The 30 samples of each material were divided into two groups (I, II), 15 samples each. The first group is for surface roughness test and the second for hardness.

The 15 samples of group I were subjected for roughness test, profilometer device (surface roughness tester). The device is supplied with a surface analyzer (sharp stylus) to trace the profile of the surface regularities and recording all the peaks and recess, which characterize the surface. Two measurements were done for each sample and a mean is calculated.

The 15 samples for hardness test were tested with a vicker's hardness tester with load 10g so that the indentation could be properly measured. Two measurements were done for each sample and a mean is calculated.

The 15 samples of group I were subjected for roughness test, profilometer device (surface roughness tester). The device is supplied with a surface analyzer (sharp stylus) to trace the profile of the surface regularities and recording all the peaks and recess, which characterize the surface. Two measurements were done for each sample and a mean is calculated.

Each test group contains five samples from the three different types of materials we used. We repeated those measurements (surface roughness and hardness measurements) for all the samples after sterilization in the microwave at full power 800wat for 10 mints.

RESULTS

The mean and SD for surface roughness value for all materials before and after disinfection are listed in table 1.

For the hot cure acrylic resin and cold cure acrylic resin, there is significant increase (P< 0.05) in surface roughness values. After disinfection in microwave in the three different groups (nacl, w, d) as shown in Figure 1 and 2.

For soft liner material there is a highly significant increase (P< 0.01) in surface roughness value after disinfection in microwave for 10 minutes in the three different groups (nacl, w, d) as shown in Figure 3.

The mean and SD for hardness value for all materials before and after disinfection are listed in table 1. For the hot cure acrylic resin and cold cure acrylic resin, there is significant increase (P< 0.05) in surface roughness values. After disinfection in microwave in the three different groups (nacl, w, d) as shown in Figure 1 and 2.

For soft liner material there is a highly significant increase (P< 0.01) in surface roughness value after disinfection in microwave for 10 minutes in the three different groups (nacl, w, d) as shown in Figure 3.

The mean and SD for hardness value for all materials before and after disinfection are listed in table 2. There is no significant difference in hardness values before and after disinfection in microwave for 10 minutes in different conditions for the cold cure acrylic resin, for hot cure
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Table 1: Mean (SD) and paired test values of roughness of materials before and after sterilization.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Mean (SD) before</th>
<th>Mean (SD) after</th>
<th>t</th>
<th>df</th>
<th>P  value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H nacl</td>
<td>0.027 (0.0044)</td>
<td>0.029 (0.0046)</td>
<td>4.00</td>
<td>4</td>
<td>0.016</td>
</tr>
<tr>
<td>H W</td>
<td>0.029 (0.0030)</td>
<td>0.031 (0.0031)</td>
<td>2.44</td>
<td>4</td>
<td>0.040</td>
</tr>
<tr>
<td>H D</td>
<td>0.024 (0.0053)</td>
<td>0.035 (0.0035)</td>
<td>5.69</td>
<td>4</td>
<td>0.050</td>
</tr>
<tr>
<td>C nacl</td>
<td>0.033 (0.0042)</td>
<td>0.354 (0.0045)</td>
<td>2.71</td>
<td>4</td>
<td>0.055</td>
</tr>
<tr>
<td>C W</td>
<td>0.029 (0.0030)</td>
<td>0.030 (0.0030)</td>
<td>1.63</td>
<td>4</td>
<td>0.03</td>
</tr>
<tr>
<td>C D</td>
<td>0.033 (0.0035)</td>
<td>0.041 (0.0037)</td>
<td>2.84</td>
<td>4</td>
<td>0.047</td>
</tr>
<tr>
<td>L nacl</td>
<td>0.0142 (0.002)</td>
<td>0.0172 (0.001)</td>
<td>4.74</td>
<td>4</td>
<td>0.009</td>
</tr>
<tr>
<td>L W</td>
<td>0.015 (0.001)</td>
<td>0.0166 (0.002)</td>
<td>5.143</td>
<td>4</td>
<td>0.007</td>
</tr>
<tr>
<td>L D</td>
<td>0.0146 (0.0013)</td>
<td>0.0238 (0.0034)</td>
<td>7.184</td>
<td>4</td>
<td>0.002</td>
</tr>
</tbody>
</table>

P>0.0 non significant difference, p<0.05 significant difference, p<0.01 highly significant difference

Figure 1: Histogram of roughness test for hot cure acrylic resin before and after microwave disinfection

Figure 2: Histogram of roughness test for cold cure acrylic resin before and after microwave disinfection

Table 2: Mean (SD) and paired test values of Hardness of materials before and after sterilization.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Mean (SD) before</th>
<th>Mean (SD) after</th>
<th>t</th>
<th>df</th>
<th>P  value</th>
</tr>
</thead>
<tbody>
<tr>
<td>H nacl</td>
<td>15.36 (3.77)</td>
<td>15.43 (3.96)</td>
<td>0.435</td>
<td>4</td>
<td>0.68</td>
</tr>
<tr>
<td>H W</td>
<td>14.84 (3.65)</td>
<td>14.92 (3.73)</td>
<td>1.434</td>
<td>4</td>
<td>0.22</td>
</tr>
<tr>
<td>H D</td>
<td>14.14 (2.80)</td>
<td>14.16 (2.81)</td>
<td>0.076</td>
<td>4</td>
<td>0.94</td>
</tr>
<tr>
<td>C nacl</td>
<td>16.32 (2.67)</td>
<td>16.63 (2.92)</td>
<td>1.229</td>
<td>4</td>
<td>0.28</td>
</tr>
<tr>
<td>C W</td>
<td>15.87 (2.28)</td>
<td>15.90 (2.83)</td>
<td>0.236</td>
<td>4</td>
<td>0.82</td>
</tr>
<tr>
<td>C D</td>
<td>16.12 (2.06)</td>
<td>16.22 (2.61)</td>
<td>0.273</td>
<td>4</td>
<td>0.79</td>
</tr>
<tr>
<td>L nacl</td>
<td>5.00 (0.43)</td>
<td>5.20 (0.43)</td>
<td>1.267</td>
<td>4</td>
<td>0.27</td>
</tr>
<tr>
<td>L W</td>
<td>4.93 (0.61)</td>
<td>5.07 (0.48)</td>
<td>1.192</td>
<td>4</td>
<td>0.29</td>
</tr>
<tr>
<td>L D</td>
<td>4.81 (0.59)</td>
<td>5.15 (0.38)</td>
<td>2.582</td>
<td>4</td>
<td>0.06</td>
</tr>
</tbody>
</table>

P>0.05 non significant difference, p<0.05 significant difference, p<0.01 highly significant difference

Figure 3: Histogram of roughness test for soft liner before and after microwave disinfection

Figure 4: Histogram of Hardness test for hot cure acrylic resin before and after microwave disinfection
DISCUSSION

To measure the surface roughness value, we use the profilometer device because it appears to be excellent device for studying the surface roughness of denture base materials. It gives nearly the estimated value of surface roughness and give quantitative measurements that can be evaluated and compared statically (19) so we use this device in our study.

The hypothesis that microwave disinfection methods could cause adverse effect on the roughness of the denture base and reline materials was accepted.

In this study, microwave irradiation disinfection significantly increase the surface roughness of the hot and cold acrylic resin and highly significant increase the surface roughness of soft liner material, one possible explanation for these findings is that the high temperature reached during the disinfection procedure lead to alteration in the surface of material thus increase their surface roughness.

Craw and Loyd explain the increase in surface roughness result of specimens of a heat polymerizing acrylic denture base materials subjected to boiling water were found to exhibit breakdown of the surface layer probably as result of micro crazing of the surface ,with the lose of integrity as indicated by scanning electron microscopy observation (20).

The highly significant increase in surface roughness of liner materials may also be related to the fact that the level of the residual monomer in auto polymerized acrylic resin is higher in the surface layer (21,22).

Ana lucia and Lary also found similar results, they found a significant increase in surface roughness of two hard chair side reline resins and heat polymerizing denture base resin after repeated microwave disinfection (23).

For hardness test we use a vicker hardness tester because it seem to be preferable and availed tool for testing denture base materials because they provide an average reading over an appreciable area of the materials and not affected by small surface defect. (6,24)

The absence of negative effect of microwave disinfection methods on the hardness of denture base acrylic resin and soft liner is in agreement with other studies which also found that repeated microwave disinfection or treatment with worm water did not result in significant changes in hardness for the heat polymerizing acrylic resins evaluated.

Dixon et al evaluated the 15-minute irradiation of non-immersed specimens and 5 minutes irradiation of specimens immersed in water did not result in a significant change in hardness for the molloplast-B and Lucitone 199 materials. (13).

Lucia found that the hardness of denture base acrylic resin remain unaffected after microwave disinfection (23), this is similar to what we find in our study.

REFERENCES