EFFECTS OF MICROWAVE IRRADIATION ON THE DIMENSIONAL STABILITY OF COMPLETE DENTURE BASES: AN ORIGINAL RESEARCH

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ABSTRACT

Aim: The purpose of this study was to perform an in-vitro investigation, testing and comparing the effects of microwave irradiation on the dimensional stability of three types of complete denture bases.

Methodology: Thirty maxillary complete dentures were fabricated using three commonly used complete dentures base brands (Eclipse, Ivocap, Lucitone199). Dentures were subjected to daily microwave irradiation (1300 W) for three minutes immersed in sterile water. Measurements were made after the specimens were fabricated, and then at one, two, and three months. The dimensional stability of the different complete denture bases were evaluated. Data was statistically analyzed using a 2-way repeated measures ANOVA; followed by the Tukey HSD test. Statistical analysis was conducted at the 95% level of confidence ($\alpha =.05$).

Results: When comparing to the baseline, the Eclipse group had a mean shrinkage of 0.083% at one month with a standard error of 0.021; 0.14% (0.025) of shrinkage at two months; and 0.23% (0.026) of shrinkage at three months. The Ivocap group had 0.069% (0.013) shrinkage at one month; 0.16% (0.015) shrinkage at two months; and 0.25% (0.025) of shrinkage at three months. And the Lucitone group had 0.13% (0.017) of shrinkage at one month; 0.19% (0.023) of shrinkage at two months; and 0.33% (0.023) of shrinkage at three months.

Conclusion: Microwave irradiation did not seem to reveal any clinical significance on the dimensional stability of Eclipse, Ivocap and Lucitone 199 denture bases when used at the wattage and time settings used in this study.

Keywords: dimensional stability, acrylic resin, denture base materials.

INTRODUCTION
Contamination of removable prostheses with microorganisms (e.g. bacteria, fungi or viruses) turns them into sources of infection risk that may affect denture wearers and dental professionals. It is imperative that such prostheses be disinfected, at the dental surgery or laboratory, to reduce risks of cross-contamination and to comply with infection control guidelines. Several methods of disinfection have been suggested, mainly including immersion of dentures in chemical solutions of sodium hypochlorite, alkaline glutaraldehyde, 4% chlorhexidine, chlorine dioxide, and denture cleansers such as alkaline peroxides, herbal and photodynamic therapy. However, past studies have indicated that such solutions affect the physico-mechanical properties of the materials used to construct removable prostheses. Furthermore, bleaching of dental base materials, unpleasant taste to patients and oral tissue reactions are some of the adverse effects of chemical disinfectants. The use of such solutions has also been considered to be time-consuming. To overcome the above drawbacks, microwave energy was proposed as a simple, safe, low-cost and effective alternative method of disinfection. Microwave irradiation of dentures is performed by either the wet (placed in a water bath) or dry disinfection method. The microwave energy ranges between 450-650 W for a period of 2 to 10 minutes. However, temperature developing during microwave disinfection may have a negative impact on polymer structure. The fact that water starts boiling after 90 seconds of irradiation and the appliance remains at this temperature until the end of the disinfection cycle may further enhance an acrylic resin polymerization reaction, which in turn may result in denture distortion. Furthermore, it is well documented that temperature levels exceeding 77°C may distort the base of the denture due to the release of internal stresses trapped within the material during the polymerization procedure. In order to minimize undesirable side effects of exposure to excessive temperature during microwaving, some researchers have recommended adding alkaline peroxide to the plain water to reduce the time that the denture base is exposed to high temperatures. Color is considered a significant parameter for the aesthetic appearance of dentures since color change acts as an indicator of material aging or damage. Previous studies examined the effects of denture cleansers on the color stability of denture base materials, but there is little information on the effect on color of microwave irradiation as a method of disinfection. Polychronakis, et al. revealed no significant changes either in PMMA color or polyamide denture base materials after a short cleansing period of 30 cycles, with a solution prepared by dissolving a Corega tablet in 200 mL of water and combined with microwave irradiation (450 W for 2 minutes). Translucency is also an important property of denture aesthetics. Denture base materials should have a color similar to normal soft tissues, but also a translucency that will allow the light to pass through and reflect back normal tissue shades for a more natural appearance. It is important that both color and translucency of denture base materials be maintained throughout their clinical use. However, there are no studies focusing on the translucency of denture base materials and how much it is affected by their color changes. Dimensional stability of dentures during processing and while in-service is of great importance for denture fit and patient satisfaction. The effects of microwave disinfection on the dimensional stability of denture base materials have been extensively studied, and some of them showed significant dimensional changes, while others reported dimensional stability.

AIM OF THE STUDY
The purpose of this study was to perform an in-vitro investigation, testing and comparing the effects of microwave irradiation on the dimensional stability of three types of complete denture bases.

METHODOLOGY
An edentulous master cast with reference points was fabricated and duplicated. Thirty maxillary complete dentures were fabricated using three commonly used complete dentures base brands (Eclipse, Ivocap, Lucitone199). (Table 1) Dentures were subjected to daily microwave irradiation (1300 W) for three minutes immersed in sterile water. Measurements were made after the specimens were fabricated, and then at one, two, and three months. The dimensional stability of the different complete denture bases were evaluated by comparing the baseline dimensions to the dimensions of each test group at the different time periods (1, 2 and 3 months interval). The overall dimensional changes of the simulated complete dentures being tested were estimated by using the percentage difference between the baseline area of each denture base and each test group. Data was statistically analyzed using a 2-way repeated measures ANOVA; followed by the Tukey HSD test. Statistical analysis was conducted at the 95% level of confidence ($\alpha=0.05$).

**RESULTS**

When comparing to the baseline, the Eclipse group had a mean shrinkage of 0.083% at one month with a standard error of 0.021; 0.14% (0.025) of shrinkage at two months; and 0.23% (0.026) of shrinkage at three months. The Ivocap group had 0.069% (0.013) shrinkage at one month; 0.16% (0.015) shrinkage at two months; and 0.25% (0.025) of shrinkage at three months. And the Lucitone group had 0.13% (0.017) of shrinkage at one month; 0.19% (0.023) of shrinkage at two months; and 0.33% (0.023) of shrinkage at three months. (Table 2) A Related Samples Friedman’s Two-Way ANOVA was used to determine if each group was statistically significantly different at each month throughout the study. When comparing the Eclipse group at baseline, one month, two months and three months a p-value of 0.000 was observed. The same p-value of 0.000 was found for both the Ivocap and Lucitone groups. None of the groups exceeded the average 0.5% linear polymerization shrinkage.

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TYPE OF RESIN</th>
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<tr>
<td>Lucitone 199</td>
<td>Heat polymerised acrylic resin</td>
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<tr>
<td>Eclipse</td>
<td>Light cured resin</td>
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<tr>
<td>Ivocap</td>
<td>Heat polymerised acrylic resin injection system</td>
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**DISCUSSION**

Microwave irradiation is a proven way of disinfecting dentures. In the present study, three different types of dentures bases were evaluated for dimensional stability. After three months...
of daily microwave irradiation exposure, shrinkage was observed in all three groups. It was determined that there were statistically significance differences affecting the denture dimensional stability on the Eclipse and Lucitone 199 groups, and no statistically significance affecting the Ivocap group. Although there were statistically significant differences on the changes obtained for two groups, it was determined that these changes were not clinically significant when compared to denture processing shrinkage. The initial polymethylmethacrylate formation has 21% volumetric shrinkage and 7% linear shrinkage. In order to increase the accuracy of denture bases the polymethylmethacrylate is pre-polymerized to reduce shrinkage. So for a 3:1 polymer to monomer ratio the volumetric shrinkage is 6% and the linear shrinkage is 0.5%.17 The test groups Eclipse, Ivocap and Lucitone had a total shrinkage of 0.23%, 0.25% and 0.33% respectively; each of the tested groups had less than the 0.5% linear shrinkage obtained from processing with the conventional packing technique. The present study is in accordance with the findings of Burns et al18 who tested three acrylic resin materials and found that they maintained excellent stability; the materials that were tested had shrinkage values in the range of 0.02% to 0.03%. They concluded that the shrinkage obtained from microwave irradiation is clinically insignificant compared to polymerization shrinkage39. In their study they included one brand of the denture bases of the present study, Lucitone199® Dentsply (York, PA), but the samples used were not conventional dentures, they were cylinders uniform in size and volume, dimensions for the cylinders was 36 mm in length and 6 mm in diameter. Basso et al19 also reported on dimensional stability, however because the shrinkage was less than 1% they determined they were not clinically significant.20 This study also agrees with the results reported by Polyzois et al.21 They concluded that all specimens exhibited linear changes during disinfection procedures. Although these changes were statistically significant, they were not of clinical importance (< 0.03%).17 However, they didn’t use simulated dentures and the materials used were different from the present study. The samples used were rectangular in shape with dimensions of 65 mm of width, 10 mm of height and 2.5 mm of depth and fabricated using a heat-polymerized acrylic resin. From the results obtained in the present study, it was determined that microwave irradiation of dentures immersed in water is another technique that can be used to disinfect dentures daily over the three month test period used in this study (1300 Watts for 3 minutes). Microwave appliances are available in most homes and allows patients to have an alternative method for maintaining their prostheses.

CONCLUSION
Microwave irradiation revealed statistical difference on the dimensional stability of Eclipse and Lucitone 199 denture bases as compared to Eclipse which demonstrated the least amount of distortion among the denture bases tested. Microwave irradiation did not seem to reveal any clinical significance on the dimensional stability of Eclipse, Ivocap and Lucitone 199 denture bases when used at the wattage and time settings used in this study.

REFERENCES


