



The Effect of Different Techniques of Microwave Disinfection on Elastomeric Impression Materials (Laboratory and Microbiological Study)

Authors

Ahmed Abd El-Hamid¹, Enaya Shararah², Dawlat Mostafa³, Shams Arafa⁴,
Eman Sabry⁵

¹Professor of Prosthodontics, Alexandria University Faculty of Dentistry, Alexandria, Egypt

²Professor of Prosthodontics, Alexandria University Faculty of Dentistry, Alexandria, Egypt

³Lecturer of Dental Biomaterials, Alexandria University Faculty of Dentistry, Alexandria, Egypt

⁴Lecturer of Medical Microbiology and Immunology, Alexandria University Faculty of Medicine, Egypt

⁵BDS, Faculty of Dentistry, Alexandria University, MS, Alexandria University, Egypt

Abstract

Dental impressions are often contaminated by exposure to saliva and blood. Microwave irradiation and immersion in solutions have been recommended for denture disinfection. However, the effect on impression materials has not been studied enough. Accordingly, the question is, is it possible to apply "Microwave disinfection" to impression materials vinyl siloxanether, polyvinyl siloxane and polyether? And if yes is it better to use with or without hydrogen peroxide (H₂O₂)? The Aim of this study is to evaluate and compare the effect of different techniques of microwave disinfection (microwave for 1 minute, 3 minutes and microwave with H₂O₂ for 1 minute and 3 minutes) on elastomeric impression materials (laboratory and microbiological study). Materials and methods: Specimens were made with vinyl siloxanether (Group I), polyvinyl siloxane (Group II) and polyether (Group III). Experimental groups were divided into Subgroup I :No disinfection measures (control group) , Subgroup II: The disinfection of samples were carried using microwave 630 w immersed in saline for 1 minute, Subgroup III: The disinfection of samples were carried using microwave 630 w immersed in saline for 3 minutes, Subgroup IV: The disinfection of samples were carried using microwave 630 w immersed in hydrogen peroxide for 1 minute, Subgroup V: The disinfection of samples were carried using microwave 630 w immersed in hydrogen peroxide for 3 minutes. The disinfection effect on bacteria and physical properties of impressions were evaluated. Result; Different techniques were significantly different (P< .05) when compared with the control in reducing the number of colony forming units (CFU) per unit volume (mL) for both streptococcus mutans and candida albicans. The most significant reduction in the CFU/mL was noted when the disinfection of samples was carried using microwave 630 w with hydrogen peroxide for 3minutes. No statistically significant difference was noted between the control and treatment groups in terms of all the physical properties tested (P>.05). Conclusion; Microwave disinfection decreased the CFU/ml of microorganisms in dental impressions, but it is more effective when samples immersed in hydrogen peroxide. Microwave disinfection with or without hydrogen peroxide had no effect on physical properties of polyvinyl siloxanether and polyvinyl siloxane but cause dimensional changes for polyether.

Keywords: microwave disinfection, elastomeric impression materials, hydrogen peroxide.

1. Introduction

Several items such as impressions, dental appliances and others are often heavily contaminated with microorganisms from saliva and blood. The risk of infections transmitted by saliva, blood and plaque is considered a potential occupational hazard as they contain pathogenic microorganisms and viruses which can transmit diseases from simple to highly virulent such as common cold, pneumonia, tuberculosis, viral hepatitis B and C, herpes and acquired immunodeficiency syndrome.⁽¹⁾

When considering methods and products for disinfection impressions, two factors are important: the antibacterial efficiency of disinfection procedures⁽²⁾ and the effect of these procedures on surface properties such as detail reproduction, surface roughness and wettability and dimensional alterations⁽³⁾

Chemical treatment (with, for example, glutaraldehyde, sodium hypochlorite, or povidone iodine) is the most commonly used method of disinfecting dental impressions. However, glutaraldehyde induces inhalation toxicity and eye irritation, sodium hypochlorite induces the bleaching of dental materials, and povidone iodine induces loss of pigmentation.^(4,5)

Microwave ovens are simple to use, low in cost and can provide disinfection effect.⁽⁶⁾ The disinfection of dentures with microwave irradiation has been attempted and has been found to be better than the use of sodium hypochlorite.⁽⁷⁾

Hydrogen peroxide (H₂O₂) is commonly used disinfectant. Its effect caused by reactive oxygen molecules and such effect will therefore be enhanced if hydrogen peroxide is in the gaseous phase. It is found that, when microwave irradiation and certain concentrations of H₂O₂ were applied to sewage sludge at the same time, the formation of OH⁻ caused by the microwave irradiation splitting the H₂O₂ confirmed that, this combination destroyed bacterial cell walls and therefore provided more effective disinfection.⁽⁸⁾

The present study is intended to compare the anti-microbial efficacy as well as the effect on dimensional accuracy and tear strength for polyvinyl siloxane, vinyl siloxanether and polyether impressions using microwave irradiation with and without hydrogen peroxide.

2. Material and Method

The present research includes two studies: microbiological study and laboratory study.

2.1. Microbiological study: An estimated sample size of 18 patients was selected, they were partially edentulous, weren't partially denture wearers. For each group, one type of impression material was used for 6 patients.

Group I: impressions were made from vinyl siloxanether (Identium® Medium, kettenbach GmbH)

Group II: impressions were made from polyvinyl siloxane (Elite® HD+ Regular Body, Zhermack).

Group III: impressions were made from polyether (Impregum® F, Handmix 3M ESPE Company). For each patient, 5 maxillary impressions were made to be divided into 5 subgroups

Subgroup I: No disinfection measures (Control group)

Subgroup II: The disinfection of samples was carried using microwave (DAEWOO, KOREA) 630w for 1 minute. (Samples were immersed in a beaker containing 40 ml saline).

Subgroup III: The disinfection of samples which immersed in saline was carried using microwave for 3 minutes.

Subgroup IV: the disinfection was carried using microwave and hydrogen peroxide (Samples were immersed in a beaker containing 40 ml of 3% H₂O₂) for 1 minute.

Subgroup V: The disinfection of samples which immersed in H₂O₂ was carried using microwave for 3 minutes.

After disinfection, each specimen was soaked in 40 ml of sterile physiological saline.

In microbiological Lab, the following culture media were prepared:

1- MacConkey's agar plates.

2- Sabouraud's dextrose agar plates.

The plates were incubated at 37⁰C aerobically. After incubation, the plates were examined for colonial growth. Microbial colonies were counted with the help of a magnifying glass. The count was then multiplied by reciprocal of the drop volume (0.01 ml) to give the viable count which is the colony forming units per milliliter (CFU/ml). The colonies were picked up separately. A gram stained film was prepared for each colony and examined under light microscopic.

2.2. Laboratory study

2.2.1. Dimensional stability test: Specimens were prepared by a standardized die according to the ADA specification No. 19 for elastomeric impression materials.⁽⁹⁾ (fig.1) Measurements were made using a Tool Maker's measuring microscope (MSSI Company, West Germany). The distance between the cross lines cd & c'd' on the test block was measured and recorded as reading (L1). The specimens were evaluated after disinfection recorded as reading (L2). According to ADA the percentage of linear dimensional change for each specimen:

$$\Delta L = \frac{L1 - L2}{L1} \times 100$$



Fig. (1): A Metal die for making test specimens to evaluate dimensional changes.

2.2.2 Tear strength test: Specimens were made 90-degree angle – shaped free of nicks with a thickness of 1.8 mm according to the ASTM 1004⁽¹⁰⁾. After disinfection they were loaded in tension until failure at a rate of 51 mm/min with a universal testing machine (USA Model No 942D 10-20) (fig.2).

The tear strength was calculated $T = F/D$ N/mm

Where: T: is tear strength, F: is the force required to cut the sample, D: is the thickness of the sample.

3. Statistical Analysis

The resulting data were fed to the computer and analyzed using IBM SPSS software package version 20.0. For normally distributed data, comparison between more than two populations was analyzed F-test (ANOVA) to be used and Post Hoc test (Scheffe). Correlations between two quantitative variables were assessed using Pearson coefficient. Qualitative data were described using number and percent. Comparison between different groups regarding categorical variables was tested using Chi-square test.

Tukey LSD. Significance test results were quoted as two-tailed probabilities. Significance of the obtained results was judged at the 5% level. A p-value of less than 0.05 was considered statistically significant.

4. Results

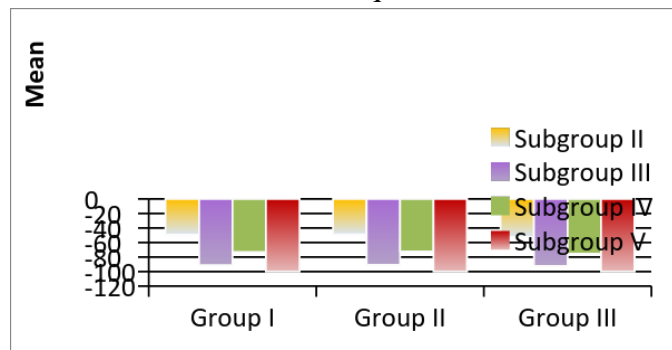
Percentages of decreasing of streptococcus mutans (CFU/ml) in different groups (different types of impressions) after disinfection with microwave for 1 min range from -49.00% to -52.36%, microwave with H₂O₂ for 1 min range from -73.31% to -75.38%, microwave for 3 min range from -91.12% to -92.44% while after disinfection with microwave for 3 min with H₂O₂ reach -100%. (Graph.1) Percentages of decreasing of candida albicans (CFU/ml) in different groups after disinfection with microwave for 1 min range from -38.33 % to -47.39 %, microwave with H₂O₂ for 1 min range from -45.50 % to -55.42 %, while after disinfection with microwave for 3 min with or without H₂O₂ reach -100%. (Graph.2)

Linear dimensional changes in group I and group II after different disinfection techniques, were insignificantly different (p value >0.05) when comparing between the five subgroups, but in group III there were significant differences (P<.05). There were significant differences when comparing between three groups after disinfection 3min with microwave with or without H₂O₂.

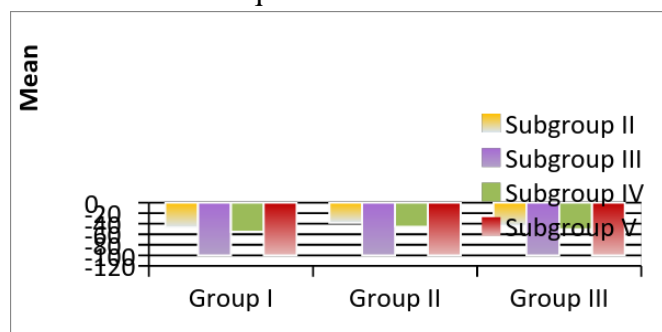
Tear strength, there was no statistically significant difference (p >> 0.05) when comparing between

three groups also when comparing between the five subgroups in each 3 groups.

Graph (1): Comparison between percentages (%) of decreasing of streptococcus mutans from control in different impression specimens after different disinfection techniques.



Graph (2): Comparison between percentages (%) of decreasing of candida albicans from control in different impression specimens after different disinfection techniques.



5. Discussion

Disinfection with microwave for 3 minutes resulted in survival of Streptococcus mutans after 24 incubation. Only the 3-minute specimens disinfected in microwave with H₂O₂ showed no CFU. The result obtained from present study was supported with vitro study of Choi et al. (2014) ⁽¹¹⁾ who evaluate the effectiveness of microwave irradiation and hydrogen peroxide against S mutans and E coli for the polyvinyl siloxane impression materials. This because the formation of hydroxyl free radicals caused by the microwave irradiation splitting the H₂O₂, this combination destroyed bacterial cell walls and therefore provided more effective disinfection.

Disinfection with microwave for 3 minutes with or without H₂O₂ showed no CFU of Candida

albicans. These results were in agreement with Campanha et al.(2013)⁽¹²⁾ they demonstrated that microwave irradiation inactivated *C. albicans* after 3min.

Linear dimensional changes after disinfection for vinyl siloxanether and polyvinyl siloxane specimens were insignificantly different from control, but for polyether some linear dimensional changes occur. These results were in agreement with Thota et al. (2014) ⁽¹³⁾, as polyether impression materials show same behavior when disinfected by autoclave because of their hydrophilic nature. So, following cold disinfection procedure is indicated for polyether.

The results of tear strength test showed that the three used impression materials after different disinfection techniques weren't significantly different from control specimens. The results were in agreement with Choi et al. (2014) ⁽¹¹⁾ who reported that microwave irradiation and hydrogen peroxide disinfection had no effect on tear strength of polyvinyl siloxane impression materials.

6. Conclusion

Microwave disinfection decreased the CFU/ml of microorganisms in dental impressions, but it is more effective when samples immersed in hydrogen peroxide. Microwave disinfection with or without hydrogen peroxide had no effect on physical properties of polyvinyl siloxanether and polyvinyl siloxane but caused dimensional changes for polyether.

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