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DIMENSIONAL STABILITY AND SURFACE ROUGHNESS OF A NEW ADDITION SILICONE IMPRESSION MATERIAL AFTER AUTOCLAVE STERILIZATION AND CHEMICAL DISINFECTION

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ABSTRACT

Objective: To evaluate dimensional stability and surface roughness of a new addition silicone impression material after autoclave sterilization and chemical disinfection. **Material and methods**: A total of 36 impressions were made of metal master model attached with three customized abutments using the autoclavable poly vinyl siloxane impression material (AFFINIS, Coltene/ Whaledent AG, 9450 Alstalten, Switzerland).Impressions of the master cast were divided into three groups. Group C (control group): Impressions were poured without any interference, Group A: Impressions were autoclave sterilized, Group B: Impressions were disinfected with glutaraldehyde solution. Then impressions were poured in to gypsum casts on which dimensional stability and surface roughness were measured with microscope and optical profilometer. **Results:** Surface roughness did not change significantly after disinfection or sterilization ($p>0.05$), whereas dimensional stability did not change significantly after chemical disinfection but did change significantly after autoclave sterilization ($p \leq 0.05$), but this is not clinically significant because it is within the ISO 4823limits for elastomeric impression materials 1.5%. **Conclusion:** After chemical disinfection and autoclaving, there were no clinically significant changes in the dimensional stability and surface roughness of the addition silicone impression material.

KEYWORDS: Dimensional stability, Surface roughness, Impression, Autoclave, Disinfection.

INTRODUCTION

Dental professionals are exposed to a wide variety of micro-organisms in the blood and saliva. These micro-organisms may cause infectious diseases such as pneumonia, acquired immune deficiency syndrome (AIDS), tuberculosis, herpes, hepatitis B and C and recently COVID 19. (On an average, 1ml of a healthy person's saliva contains about 750 million microorganisms. Numerous studies have reported the colonization of distinct bacterial communities on different oral structures and tissues, and about 280 bacterial species from the oral cavity have been isolated [(1-3)].

Dental impressions can act as vehicle for transport of these infectious diseases between the patient , dentist and the technician. British Dental Association (BDA), American Dental Association (ADA) and Center for Disease Control (CDC) suggested and recommended to decontaminate and disinfect the dental impressions before they were sent to the dental laboratory and it has evidently specified that the dentist is solely

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responsible for disinfection of the impression before it is being sent to the laboratory [4, 5].

A basic principle of infection control is to sterilize rather than disinfect whenever possible. Because sterilization can eliminate all micro-organisms, including bacterial spores, although sterilization is a preferred method of cross-infection control in the clinic, manufacturers have not investigated the sterilization of their impression materials. Manufacturer's instructions still recommend disinfecting impression materials by using chemical solutions [6].

Addition silicone (polyvinylsiloxanes) represents the state of art in elastomeric impression materials in prosthodontics and restorative dentistry. It is used for recording the impressions of dentulous and edentulous arches, duplication of casts and bite registrations. Recently, new elastomeric impression materials with very high elastic recovery and high tear strength have been introduced [7].

Having a smooth surface is a major requirement of the impression material because it not only prevents plaque and calculus accumulation but it also improves esthetics. Furthermore, surface roughness on the tissue surface of the prosthesis may affect the fit and acceptance of the prosthesis. Any surface defects or irregularities in the impression may result in an irregular and ill-fitting prosthesis [8, 9].

When considering the method of disinfection or sterilization, two factors are important. First is the efficiency of the used method and its ability to kill all the micro-organisms. The second is not to adversely affect the unique properties of the impression material, like dimensional stability and surface properties [10, 11].

In recent years, a new product has claimed to be the first ever autoclavable vinylpolysiloxane impression material, and it can be autoclaved at 134ºc without losing its unique properties [12]. In this study, the clinical feasibility and overall dimensional stability and surface roughness of this autoclavable impression material will be checked.

MATERIALS AND METHODS

An in vitro controlled experimental study was carried out at laboratory of removable prosthodontics Department, Faculty of Dental Medicine Al-Azhar University Cairo Egypt, to evaluate dimensional stability and surface roughness of polyvinyl siloxane impression materials (AFFINIS, Coltene/Whaledent AG, 9450 Alstalten, Switzerland) after stem sterilization (autoclaving) and chemical disinfection (glutaraldehyde 2% solution ,Global Pharma,Egypt).

Methodology

A metal master model representing maxillary edentulous alveolar ridge, was designed and manufactured; Three customized abutments A, B, C were then machined (22mm height and 3mm diameter) with cross (+ shape) reference points on the occlusal aspect to facilitate future measurements of dimensions and positioned in the correspond prepared holes, figure 1.

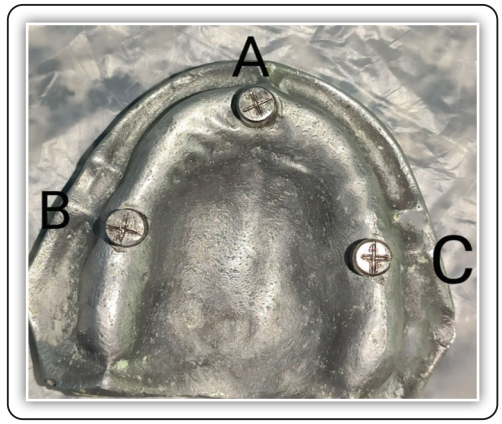

FIG (1) Metal master model

The metal master model was painted with thin layer of separating medium to prevent adhesion of the impression to it then impressions were made using polyvinyl siloxane impression materials using custom trays painted with adhesive.

The tray was loaded with the impression material to the level of the height of the borders of the

tray within the working time recommended by the manufacturer which is 90 seconds.

The tray was seated over the master model under manual pressure until the wax stoppers reached the prisms of the model; the excess material was allowed to extrude and the impression was left to set for 5 minutes.

After complete setting of the impression, it was removed by sharp snap motion and washed under tap water for 30 seconds to stimulate the oral saliva. Impressions were inspected visually to make sure reference lines are registered, figure 2.

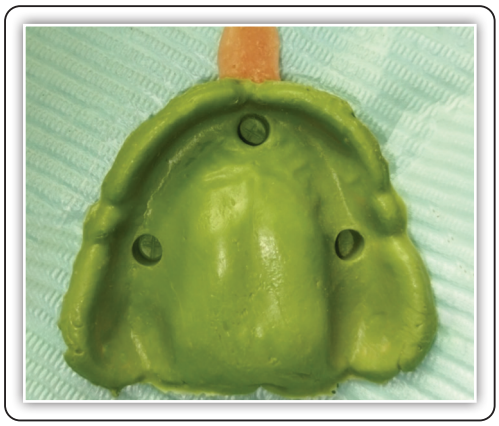

FIG (2) Impression after complete setting

Impressions grouping

Control group (C.G): 12 impressions were not subjected to any treatment.

Group A: 12 impressions were kept in sterilization bags with indicator and inserted in the autoclave at 134º (wrapped), 2.0 psi for 18 minutes and 12 minutes drying time.

Group B: 12 impressions were immersed in 2% glutaradehyde solution in plastic keeper for 10 minutes.

Control group and test specimen impressions (group A and group B) were poured with type IV low expansion extra hard stone (Zhermack Elite Stone, Zeta, Italy).

Dimensional stability and surface roughness were evaluated indirectly through stone casts from impressions of the master model using a measuring microscope and optical profilometer.

Surface roughness

Measured using non-contact (optical) laser profilometer (Zygo optical profilometer, Zygo Co ,USA). The roughness value was presented as (RA) which is the roughness average of the surface. The sample was placed on the adjustable platform so that the surface of the sample to be tested was perpendicular to the optical beam of the profilometer. Surface roughness was measured on the same three areas of each cast in each group; these areas are the right ridge, left ridge and the center of the palate of each cast the average of which was considered as the final surface roughness value.

Dimensional stability

The distances between the centers of the prisms of each cast (A-B), (A-C) and (B-C) were measured and compared to that of the control group and master model. Universal measuring microscope (UMM, Es 052, Carl Zeiss Jena, Germany) was used in this study with accuracy 200*100mm .All measurements were done by the same operator and each measure was repeated three times to monitor the operator error.

Statistical Analysis

Numerical data were tested for normality using Shapiro-Wilk test. Data showed parametric distribution so they were presented as mean and standard deviation values and were analyzed using one-way ANOVA followed by Turkey's post hoc test. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with IBM (IBM Corporation, NY, USA) SPSS(SPSS, Inc., an IBM Company) Statistics Version 26 for Windows.

RESULTS

Dimensional stability:

There was a significant difference between different groups (p<0.001). Control and disinfection groups showed the highest mean value while sterilization group showed the lowest mean value. Pairwise comparisons showed that sterilization group had significantly lower mean value than other groups (p<0.001).There was no statistically significant difference between disinfection group and control group.

TABLE (1) Mean and standard deviation (SD) values for inter-abutment distances in different groups

Measurement	Inter-abutment distance (Mean±SD)			p-value
	Control	Disinfection	Sterilization	
A-B	28.07±0.02^{A}	28.07±0.02^{A}	27.88±0.06^{B}	**<0.001***
A-C	29.61±0.03^{A}	29.62±0.07^{A}	29.30±0.02^{B}	**<0.001***
B-C	37.86±0.05^{A}	37.87±0.04^{A}	37.28±0.03^{B}	**<0.001***

Means with different superscript letters within the same horizontal row are statistically significantly different; significant (p ≤ 0.05).*

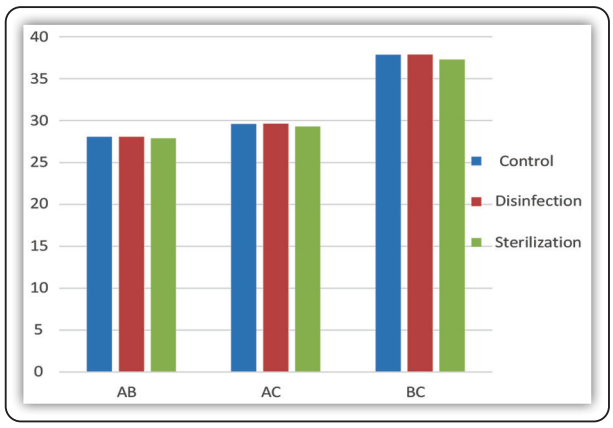

FIG (3) Bar chart showing values for inter-abutment distances in different groups

Surface roughness

There was no significant difference between different groups (p=0.590). Control and sterilization groups showed the highest mean value (0.77±0.06) (0.77±0.07) respectively while disinfection group showed the lowest mean value (0.72±0.21).

TABLE (2) Mean and standard deviation (SD) values for surface roughness in different groups

Surface roughness (Mean±SD)			p-value
Control	Disinfection	Sterilization	
0.77±0.06	0.72±0.21	0.77±0.07	**0.590ns**

ns; non-significant (p>0.05)

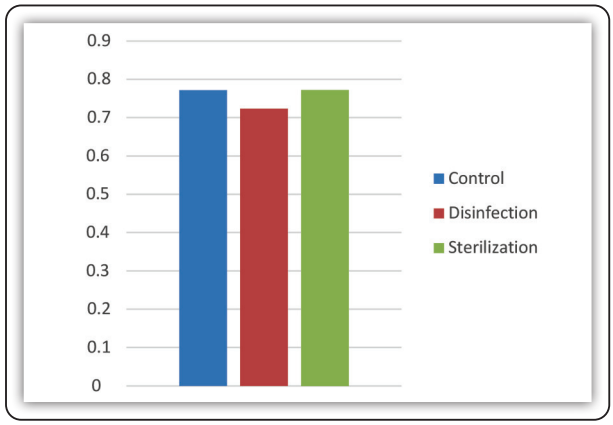

FIG (4) Bar chart showing values for surface roughness in different groups.

DISCUSSION

FDI guidelines suggested that all impression materials should be disinfected before sending to laboratory. The American Dental Association (ADA) and center for disease control (CDC) suggested disinfection of impression materials to prevent cross infection [13].

In this study glutaraldehyde 2% was used because it is a high level disinfectant. It is also called chemo sterilizer. It can destroy all types of micro-organisms including some of bacterial and fungal spores, tubercle bacilli and viruses. It is considered as the best disinfectant for cold

sterilization of medical equipment that cannot be inserted in to autoclave[14]. It has been proven that glutaraldehyde solution is active against COVID 19 corona virus at a concentration range 0.5-3% within 2 min of exposure [15].

It has been proven by many authors that 10 minutes exposure time is recommended to prevent infection transmission to dental staff and laboratory without affecting the quality and dimensions of the impressions [14-16].

Sterilization is the process of rendering an item free of all forms of viable microorganisms, including spores. In office- based dental practice, the most efficient and simplest means of sterilizing dental instruments is steam under pressure (commonly called steam sterilizing or autoclaving). It involves the combination of heat and moisture maintained at the right temperature and pressure for the right length of time to kill microorganisms. The sterilization process requires all air in the chamber be replaced by steam. Autoclaves are the most reliable and efficient sterilizing units for use in office-based practice [17].

Disinfection and sterilization procedures should not alter the roughness of the impression; Ideally, any prosthesis should not have a roughness value of more than 0.2 μm, below which no further reduction in food or plaque accumulation can be observed, and above which marked plaque accumulation is expected [18].

Dimensional stability was assessed by a measuring microscope; comparing the measurements of stone casts to those of the master model. They are very precise for scientific measurements because of their extreme accuracy and ability to measure very small measurements. Each measurement was repeated three times to monitor the operator error [19].

Surface roughness was measured by an optical profilometer because it provides full 3D topography scan, digital reading, no damage to the surface and fast scan speeds[20] .

The findings of this study revealed that there was no significant dimensional change between the disinfection and control group, despite the fact that very little degree of expansion occurred in the disinfected samples, which is in agreement with previous studies that used 2% glutaraldehyde solution for 10 minutes [16, 21].

The results of autoclave sterilized impression showed statically significant dimensional shrinkage in the casts when compared to the control group and the master model which resulted in cast with smaller dimensions but these dimensional changes are clinically acceptable since the maximum shrinkage occurred was in the cross arch distance with 1.32% which is still within ISO 4823 limits which is1.5%[21, 22].

These results are in agreement with previous studies that used autoclave to sterilize Affinis autoclavable impression material in which the polyvinyl siloxane impression material showed a contraction after autoclave sterilization. According to their studies, the shrinkage was attributed to the loss of chemical constituents from the impression martial and the tray when subjected to a high temperature of autoclave[21,23-24].

According to the findings of this study, there was no statistically significant change in the surface roughness of affinis impression material after chemical disinfection and autoclave sterilization. These results come in agreement with previous study that evaluated the effect of autoclave sterilization and chemical disinfection on the surface roughness of affinis impression material [20].

CONCLUSION

Chemical disinfection had no significant effect on the dimensions or surface roughness of the casts produced. Although autoclave sterilization had no significant effect on surface roughness, it did cause statistically significant dimensional change; however, this change is not clinically significant as it is within the ISO 4823 limits of elastomeric impression materials.

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