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Comparative evaluation of UV sterilization using corona oven disinfection on the dimensional accuracy of elastomeric impression materials - An in vitro study

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Abstract: Impressions can be a major source of infections and hence disinfection and sterilisation of impression is of utmost importance in controlling spread of infections. This study attempts to determine, and compare the effect of three different sterilisation procedures viz Autoclave sterilisation, Microwave sterilisation, Corona oven UV sterilisation on the dimensional accuracy, of addition silicone impression material. A total of forty-five specimens allotted to three different groups, Group A, Group B, & Group C respectively via simple random sampling method and were measured for dimensional accuracy, before and after the sterilisation procedure assigned for each group. A tool maker microscope with 10x magnification with accuracy of 1µm was used for the linear measurement of the impressions. Specimens in all the groups except the control group show dimensional change after sterilization procedure but were far below the ADA specification no.19 limit of ≤ 0.5 %. Least dimensional changes were noted in the Corona oven irradiation method. (Mean 25.059 ± .288). The results of the study show that the corona oven sterilization is an effective and convenient method of sterilisation, without causing significant dimensional changes.

Keywords: vinyl siloxane, autoclave sterilization, microwave sterilization, UV sterilization, dimensional accuracy.

Introduction

The risk of infection transmitted by saliva and blood is considered a potential occupational hazard in dentistry. Cross infection from one patient to another and contamination of other surfaces and equipment is always

a matter of concern in the healthcare profession.[1] The risk is higher in dentistry, where there is a high chance of close contact with the patient as well as generation of aerosol is maximum. Another often ignored but a potential source of infection is handling of dental impression and casts poured from them. In the present scenario of the pandemic COVID -19, it is much important to eliminate any minute chance of microbial transmission, without causing any harm to the desired properties of the material/ procedure. Guidelines for dental health care have also changed according to the expanding knowledge in the field and ADA suggested that all prosthodontic items and dental prosthesis should be cleaned, rinsed, & disinfected before they are handled in the dental laboratory. Recently the uses of autoclave and microwave to disinfect the impression have shown to be promising with regard to sterilisation. [2] Use of domestic microwaves have been suggested for the purpose. In view of the pandemic a new equipment Corona oven which uses UV radiation for sterilisation is available.[3] There are not much studies comparing, its efficacy to other conventional disinfection methods. Also dimensional accuracy is of utmost importance for a dental impression. Hence the aim of the present study is to compare the effect of three different methods of sterilization viz, autoclave, microwave and Corona Oven -UV on the dimensional accuracy of addition silicone impression material.

Materials & Methods

The present study is to evaluate the dimensional accuracy of addition silicone impressions after three different sterilisation methods.

Description of master model: Stainless steel die, impression mould, and raiser were fabricated according to ADA specification no. 19. A stainless-steel die of height 31mm and a raised impression table of height 3mm was made. The diameter of the impression table is 29.970mm and the total die diameter is 38mm. Three parallel lines- X, Y, Z are scribed on the impression surface of the metal die. The lines are 58µm, 24 µm, and 83 µm wide respectively, and 2.5 mm apart. Two parallel cross lines cd and c'd' were also scribed perpendicular to the above lines at a distance of 12.5 mm from the centre of the impression.

Table of the die. These lines provide specific points of intersection on the lines X, Y, Z. The distance between these points provide measurements in micrometer precision.

Fabrication of specimens: Proportioning and manipulation of light body addition silicone impression material was done according to the manufacturer's instruction. Afer placing the impression mold on the die, a homogenous mix of the impression material was placed on the center of the die and spread to fill the entire mold. Using flat glass slab, the impression material was pressed firmly under a constant load of 1kg wt. until complete setting of the material occurred. This ensured a positive metal to metal contact between the impression mold and the steel die. The impression was separated from the impression mold and die after complete set. Only those impressions without voids and defects, and with all the details recorded, were included in the study.

Grouping the specimens for testing: A total of forty-five specimens fabricated were divided into three different groups via simple random sampling method and were subjected to different disinfection techniques, autoclave, microwave, and UV modes respectively. Each specimen was measured for dimensional accuracy, before and after the sterilisation procedure assigned for each group.

Group A: autoclave at 121^{0}C for 15 mts. under 15psi pressure in a B Class frontloading Autoclave.

Group B: Microwave exposure for 8 mts in a domestic microwave Oven (specifications of the oven: voltage 230V – 50 Hz. input power 1550W, output power 1000W).

Group C: UV exposure for 8 mts in the Corona Oven (specification of CORONA OVEN 2.0, voltage -220V - 50 Hz. input power 220W. Model NO. COVN002).

Measurement & Data collection: A tool maker microscope with 10x magnification with accuracy of 1µm was used for the linear measurement of the impressions. All the specimens were fabricated and measured by one operator. The percentage dimensional change in each specimen was calculated using the formula (L-L'x100) ÷ L**.**

Results and Discussion

The present study attempted to make an evaluation of dimensional accuracy by measuring the linear dimensional change in percentage of poly siloxanes subjected to steam autoclave at 121°Celsius for 15 minutes under 15 PSI pressure, Microwave irradiation for 8mts and Corona oven irradiation for 8 minutes. Both pre and post sterilization measurements were recorded using traveling microscope. Percentage of linear dimensional change was calculated and the results obtained statistically analyzed. Specimens in all the groups except the control group show dimensional changes after sterilization procedure. Though the dimensional change was evident these changes were far below the ADA specification no.19 limit of ≤ 0.5 %. The distance between the inner profiles of the horizontal line at the point of intersection was measured with the help of travelling microscope, in the same manner by the same individual so that subjective errors will be minimized and the mean values were recorded, tabulated and analysed using t- test. All statistical tests were conducted using the SPSS software version 2020 and a p-value of ≤0.05 was considered to be statically significant.

The mean dimensional change after autoclave sterilisation was 24.906 ± .414 whereas the mean dimensional change after microwave sterilisation was 24.880 ± .403 that of corona oven irradiation was 25.059 ± .288. The dimensional changes were compared between the groups using ANOVA test and showed no statistically significant changes among the groups. The specimens sterilized with Microwave energy show mild contractions (mean- 24.880 ± .403) which may be attributed to the loss of constituents from elastomers. Specimens sterilized by steam autoclave also showed significant dimensional change but these changes were smaller than those of specimens that were sterilized by microwave oven. Least dimensional changes were noted in the Corona oven irradiation method. (Mean 25.059 ± .288). Dimensional changes produced due to any technique was not much pronounced and the values were well below the ADA specification limit of <0.5%.[11]

Contaminated Impressions are a potential source of infection. This is very crucial in transmitting infections from the clinic to dental laboratory and of course to the dental lab technician. Rowe and Forrest opined that just rinsing the impression under water is not enough to clear away all the blood and saliva because of the mucinous nature of saliva and the adhesive salivary protein.[4] ADA and Centre for Disease Control seriously recommend the disinfection of all impressions to prevent possible transmission of infectious diseases. Considering the variety of dental materials available as dental impression materials the disinfection / sterilisation protocols involved with each may differ. A major concern is the dimensional accuracy, stability, and the quality of

surface details of the impression material subjected to various sterilization or disinfection techniques.

Chemical disinfection of impression material can be achieved either by immersing or spraying the impressions with different disinfectants of specific concentrations for specified time.[5] Immersion guarantees contact with all surfaces for a relativity longer exposure time. Hence a better means of disinfection is immersion than spraying, though spraying disinfectants is the most popular method, especially for hydrophilic impression materials. [6] Steam autoclaving which involves high temperature is associated with high risk of distortion. However, addition silicone and condensation silicone impression material showed no significant changes after subjecting to autoclave sterilization with regard to accuracy, stability and surface details. [6]

Ramakrishna et al. in 2012 found that autoclaving is a suitable technique of disinfection for vinyl Poly siloxanes.[6] Most of the researchers found out autoclaving as the most effective disinfection method for condensation and addition silicone. Due to inherent hydrophilic nature of certain impression materials this is not an ideal method, especially in the case of Poly Ether and hydrocolloids.

Microwave irradiation method is considered as one of the effective means about control over microbial count. Vats et al. showed varying powers ranging from 650 Watts to 1000 watts microwave irradiation is used commonly to achieve satisfactory disinfection. [7]Working principle of microwave is based on two modes of action - thermal and non-thermal. In the thermal mode, by prolonged kinetic motion of polar molecules, microwave energy is converted into heat. There is a direct interaction of electromagnetic field with the biological molecules in the non-thermal mode. According to various researchers' microwave irradiation is as effective as chemical disinfection with sodium hypochlorite or hydrogen peroxide [6].

Yet another method of disinfection which effectively inactivates microorganism is ultraviolet irradiation. This is a recent technology in which the material to be disinfected is placed in UV disinfection chamber and exposed to UV radiation from various directions for a specified time which can be adjusted from 1 to 60 minutes.[8] UV light acts on the DNA of the cell and has good antibacterial effect. The factors influencing the effectiveness are, time of exposure, intensity of the radiation and the accessibility to microorganisms. Different researchers have conducted studies comparing various combinations of disinfection methods to study the effect of these techniques on the microbial count, dimensional accuracy and stability, as well as surface properties[9]. Most of the studies revealed that, materials subjected to various sterilization techniques undergo dimensional changes in microns, which might affect the precision of prosthodontic impression.[10]

The limitation of the study is that, it does not mimic the exact clinical scenario since the study setting was strictly in vitro. Intra oral undercuts, quantity and quality of saliva, and the microbes present in the mouth may vary from person to person. This was not taken into consideration. Also, the effect of various techniques on other properties of Vinyl Siloxane, like surface details and quality, effect on the properties of the cast etc has not been subjected to study, which can be considered as the further scope of study.

Conclusion

All the different methods employed in the study for achieving infection control cause varying degrees of dimensional change. The Clinical implication of the results can be inferred as, the microwave irradiation technique is fast and ensure low or minimum irradiation

risks and avoid the use of toxic or pungent chemical. But it demands special trays which are compatible with Microwave irradiation and does not undergo distortion by itself. But the technique used in the Corona oven, is compatible with metal as well as plastic trays, all sorts of impression materials. Materials like cotton, paper, plastic, glass metal, etc. can be sterilized in corona oven with minimum time and least radiation risk. Convenience, simplicity of the technique, and time involved in the procedure are the major determining factors in adopting any particular method as the technique of choice. Corona oven UV irradiation technique is a recent method of sterilisation, which is of immense help from a practical aspect.

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Legend Figures and Tables

Table 1: Showing Linear Dimensional Change

METHOD	MINIMUM	MAXIMUM	MEAN ± S.D. C-C'	MEAN ± S.D D-D'
CONTROL	24.796 C-C' 24.836 D-D'	25.290 C-C' 25.311 D-D'	25.092±.142	25.125±.123
METHOD 1 Group A	24.056 C-C' 25.194 D-D	24.237 C-C' 25.254 D-D	24.906±.414	24.978±.381
METHOD 2 Group B	23.955 C-C' 24.130 D-D'	25.245 C-C' 25.317 D-D	24.880±.403	24.993±.420
METHOD 3 Group C	24.044 C-C' 24.104D-D'	25.255 C-C' 25.285 D-D'	25.059±.288	25.017±.349

Table 2: Anova

	Mean square	df	F	Sig
Difference C-C'				
Btwn Grps	.139	2	1.001	.376
Within the Grps	.139	42		
Difference D-D'				
Btwn Grps	.006	2	.038	.963
Within the Grps	.148	42		

Table: 3: t- Test

	Mean ± S.D. C-C'	Mean ± S.D. D-D'	Sig. (2 tailed C-C')	Sig. (2 tailed D-D')
Control – Method 1	25.092 ± .142 24.906 ± .414	25.125 ± .123 24.978 ± .381	0.112 0.119	0.167 0.174
Control – Method 2	25.092 ± .142 24.880 ± .403	25.125 ± .123 24.993 ± .420	0.066 0.072	0.254 0.261
Control – Method 3	25.092 ± .142 25.059 ± .288	25.125 ± .123 25.017 ± .349	0.694 0.695	0.267 0.273

Figure 1: Diagrammatic representation of Die