Original Article

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Dentistry Section

A Comparative Evaluation of the Dimensional Stability of Three Different Elastomeric Impression Materials after Autoclaving – An Invitro Study

KIRAN KUMAR THOTA[1], SUJANA JASTHI[2], RAJYALAKSHMI RAVURI[3], SUCHITA TELLA[4]

ABSTRACT

Aim of the Study: The purpose of the study was to determine the effect of autoclaving on the dimensional stability of three different elastomeric impression materials at three different time intervals.

Materials and Methods: Standardized stainless steel master die as per ADA specification number 19 was fabricated. The impression materials used for the study were condensation silicone (GP1), addition silicone (GP2) and polyether (GP3). A total of 45 samples of the stainless steel die were made (n = 45), that is 15 samples for each group. Impression materials were mixed according to the manufacturer's instructions and were loaded into the mold to make an impression of the die. Impressions were identified with the help of numerical coding system and measurements were made using stereomicroscope (MAGNUS MSZ-Bi) of 0.65x magnification with the help of image analysis software (IMACE PRO-INSIGHT VERSION.The results were subjected to statistical analysis using one way analysis of variance and student t-test for comparison between the groups.

Results: Within the limitations of the study statistically significant dimensional changes were observed for all the three impression materials at three different time intervals but this change was not clinically significant.

Conclusion: It is well-known fact that all impressions should be disinfected to avoid possible transmission of infectious diseases either by direct contact or cross contamination. Immersion and spray disinfection as well as various disinfection solutions have been tested and proven to be effective for this purpose. But for elastomeric impression materials these methods have proven to be ineffective as they do not prevent cross contamination among the dental team. So autoclaving was one of the most effective sterilization procedure for condensation silicone and addition silicone. Since polyether is hydrophilic it is better to disinfect the impressions as recommended by the manufacturer or by immersion or spray atomization.

Keywords: Dimensional accuracy, Elastomeric impression materials, Infection control, Storage time

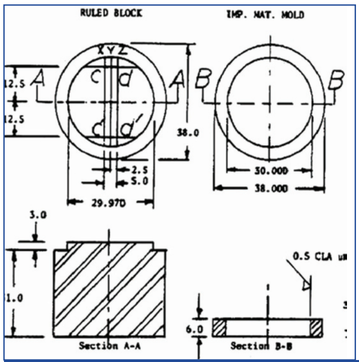
INTRODUCTION

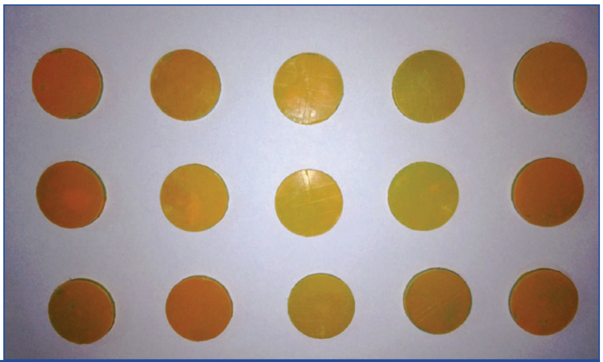
Impression making is a frequently performed procedure in the dental office that requires selection of an appropriate impression material and technique for any given procedure. Following the procedure, casts were obtained from the impression which would be used as study models or dies for the fabrication of appliances, indirect restorations and prostheses. Set impressions are a source of reservoir for pathogens which contain microorganisms - bacteria, fungi and viruses – following their removal from the patient's mouth. These microorganisms are transmitted into plaster and stone while models are being poured. These models represent a risk of disease transmission to dental healthcare workers, transporting personnel, and laboratory personnel through indirect contact [1,2]. Therefore, an appropriate infection control protocol must be followed before, during and after impression making to avoid cross-contamination and the risk of disease transmission. Autoclaving is considered to be the most effective method of sterilization however, the accuracy of different elastomeric impression materials before and after autoclaving have not been extensively studied. The purpose of this study was to determine the effect of autoclaving on the dimensional stability of three different elastomeric impression materials at three different time intervals.

MATERIALS AND METHODS

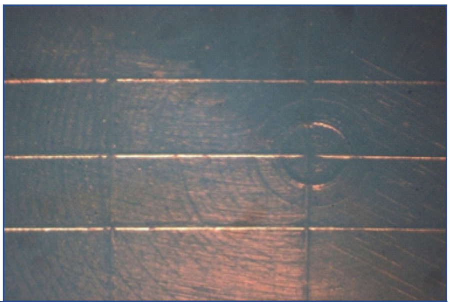
The impression materials used for the study were condensation silicone putty and light body consistencies (ZETAPLUS), addition silicone putty and light bodied consistencies (AQUASIL) and polyether heavy and light bodied consistencies (IMPREGNUM TM SOFT).These three impression materials were named as group 1, group 2 and group 3 respectively.

METHOD - Standardized stainless steel master die as per ADA specification number 19 was fabricated. The master die consists of a ruled block and a mold ring with dimensions of 31mm height and 38mm width (ruled block). A 3mm height and 29.97mm diameter step has been made on the sides of the die to which the metal mold ring fits. The die consists of three parallel lines inscribed on the surface of the die named as X, Y and Z. The dimensions of the mold ring are 38mm (outer ring), 30mm (inner ring) and 6mm height which fits around the borders as a mold for the impression material [3] [Table/Fig-1,2]. The distance between the three parallel lines is measured in the microscope at four specific points referred to as C, D and C', D' which was appx 5mm. A total of 45 samples of the stainless steel master die were made (n=45) which were divided into three groups of 15 for each material. A stainless steel ring to be used as a mould to make an impression was placed on the die. Now, double mix single impression method was used to make the impressions. Impression material was mixed according to the manufacturer's instructions and was loaded into the mold to make an impression of the die. After loading the mold, impression material was immediately covered by a thin sheet of polyethylene followed by application of sufficient force on a rigid flat metal plate to seat it firmly against the mold. To compensate for polymerization of the material at room temperature rather than at mouth temperature, the impressions were allowed to set for twice the manufacturer's recommended setting time [4]. The impression was then recovered from the mold and numeric coding system (1-15) was used to identify the samples [Table/Fig-3].





[Table/Fig-1]: Schematic representation of the master die., **[Table/Fig-2]:** Master die, **[Table/Fig-3]:** Condensation silicone samples.



[Table/Fig-4]: Stereomicroscope **[Table/Fig-5]:** Stereomicroscopic view of addition silicone sample

		Sum of Squares	df	Mean Square	F	Sig.
GP1	Between Groups	51.292	2	25.646	2.200	
	Within Groups	489.553	42	11.656		
	Total	540.846	44			
GP2	Between Groups	93.556	2	46.778	2.449	
	Within Groups	802.272	42	19.102		
	Total	895.828	44			
GP3	Between Groups	50.128	2	25.064	4.067	
	Within Groups	258.832	42	6.163		
	Total	308.960	44			

[Table/Fig-6]: One way ANOVA for three different materials

Dependent Variable	(I) GP	(J) GP	Mean Difference (I-J)	Std. Error	Sig.
GP1	1.00	2.00	.96000	1.24665	.446
		3.00	-1.62667	1.24665	.199
	2.00	1.00	-.96000	1.24665	.446
		3.00	-2.58667*	1.24665	.044
	3.00	1.00	1.62667	1.24665	.199
		2.00	2.58667*	1.24665	.044
GP2	1.00	2.00	3.30000*	1.59590	.045
		3.00	2.74000	1.59590	.093
	2.00	1.00	-3.30000*	1.59590	.045
		3.00	-.56000	1.59590	.727
	3.00	1.00	-2.74000	1.59590	.093
		2.00	.56000	1.59590	.727
GP3	1.00	2.00	1.96000*	.90647	.036
		3.00	-.48000	.90647	.599
	2.00	1.00	-1.96000*	.90647	.036
		3.00	-2.44000*	.90647	.010
	3.00	1.00	.48000	.90647	.599
		2.00	2.44000*	.90647	.010

[Table/Fig-7]: Student 't' test

Samples were measured using stereomicroscope (MAGNUS MSZ-Bi) of 0.65x magnification with the help of image analysis software (IMACE PRO-INSIGHT VERSION 8) [Table/Fig-4].The distance between the cross lines CD and C'D' were measured in the die and the measurement was recorded as reading A. Distance between the cross lines CD and C'D' reproduced in the impression were measured before autoclaving, immediately after autoclaving and 24 h after autoclaving and these measurements were recorded as B1, B2 & B3 respectively. The measurements were made at the intersection of the vertical and horizontal lines in the stereomicroscopic view [Table/Fig-5]. Dimensional change percentage was calculated using the following formula: Dimensional change% = $A – B_{1/2/3}$ /A x 100.

RESULTS

The dimensional stability was compared at three different time intervals for three different materials using one-way-ANOVA [Table/Fig-6]. A student t-test was used to ascertain the statistical difference between the groups [Table/Fig-7].

The present study evaluated and compared the effect of autoclaving on 3 different elastomeric impression materials. Within the group, significant difference in the dimensional change was observed before and immediately after autoclaving. Statistically no much dimensional change was observed between before autoclaving and 24 h after autoclaving in condensation and addition silicone. Significant difference in the dimensional change was observed in polyether material in all the three time intervals.

DISCUSSION

Elastomeric impression materials may exhibit dimensional instability due to polymerization shrinkage, release of bye products due to chemical reactions, thermal changes or incomplete elastic recovery from deformation [5]. Saliva and blood contaminated impressions are often the source of contamination between the clinic and dental lab personnel. As part of infection control protocol, proper handling of dental impressions must exist among the office staff as well as between office and dental laboratories. Sterilization results in destruction of all forms of microbial life where as disinfection results in destruction of specific pathogenic microorganisms [6].

In the current study, impressions were made from stainless steel dies following the ADA specification for elastomeric impression materials. Although this provides a protocol that can be easily replicated by others, it is not the same as making a clinical impression. For example, the protocol does not include impression trays with tray adhesive [7]. When making an impression in a tray, impression shrinkage translates into oversized dies, which is advantageous for the fabrication of a cast restoration [8]. The oversized die can help compensate for wax pattern and casting alloy shrinkage producing a crown more likely to seat. Thus, it is important that impression shrinkage is consistent, serving as a reliable factor within the expansion and shrinkage equation associated with cast restorations. This clarification is valuable in order to appreciate the clinical ramifications of dimensional accuracy changes associated with potential impression expansion following disinfection [9-12].

Group I	D1	D2	D3
Mean	-1.2400	-2.2000	0.3867
Standard Deviation	0.51796	5.77730	1.15007
Group II	D1	D2	D3
Mean	-1.1800	-4.4800	-3.9200
Standard Deviation	0.55446	6.39187	4.01768
Group III	D1	D2	D3
Mean	-0.7067	-2.6667	-0.2267
Standard Deviation	0.59338	4.15618	0.92849

[Table/Fig-8]: Mean dimensional change and standard deviations of three different materials

The mean dimensional change and standard deviation values for three different elastomeric materials before autoclaving, immediately after autoclaving and 24 h after autoclaving were tabulated [Table/Fig-8], for addition silicone and polyether the difference between the mean dimensional change before autoclaving, immediately after autoclaving and 24 h after autoclaving was statistically significant ($p<0.05$) but for condensation silicone it was not statistically significant ($p>0.05$).

The study revealed that it is necessary to delay the casting of autoclavable elastomers by 24 h and it is advised not to autoclave the polyether material as they show slight sticky (matte) surface and higher mean dimensional change because of their hydrophilic nature. Tullner et al., reported that soaking the polyether for 15 min with a solution of sodium hypochlorite, iodophor or glutaraldehyde did not produce clinically relevant changes in the impressions. So, polyether can be sterilized by following cold sterilization [13,14].

CONCLUSION

Among the various sterilization procedures available for disinfecting the elastomeric impression materials autoclaving is considered to be most effective procedure. Various studies have revealed that dimensional change exhibited by elastomers after autoclaving is significantly low. Within the limitations of this study it is considered that autoclaving is the most effective procedure for condensation and addition silicone but for polyether autoclaving results in altering the surface details (matte surface) so following disinfecting procedure recommended by the manufacturer or following cold disinfecting procedure is indicated.

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PARTICULARS OF CONTRIBUTORS:

1. Reader,Department of Prosthodontics, Kamineni Institute of Dental Sciences, Sreepuram, Narketpally, Nalgonda, Telangana, India.
2. Post Graduate Student,Department of Prosthodontics, Kamineni Institute of Dental Sciences, Sreepuram, Narketpally, Nalgonda, Telangana, India.
3. Reader, Department of Prosthodontics, Kamineni Institute of Dental Sciences, Sreepuram, Narketpally, Nalgonda, Telangana, India.
4. Reader, Department of Prosthodontics, Kamineni Institute of Dental Sciences, Sreepuram, Narketpally, Nalgonda, TElangana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Sujana Jasthi,
Post Graduate Student,Department of Prosthodontics,
Kamineni Institute of Dental Sciences, Sreepuram, Narketpally, Nalgonda, Telangana, India.
Phone : 9704558741, E-mail : sujana.jasthi@gmail.com

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