DIMENSIONAL STABILITY OF VINYLSILOXANETHER IMPRESSION MATERIAL AFTER AUTOCLAVE STERILIZATION – AN IN VITRO STUDY

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ABSTRACT

Dental impressions are often neglected in clinical practice as a source of spread of infectious diseases. In Pakistan more than fifty percent of the clinicians do not disinfect impressions. Blood and saliva contaminated impressions should be either disinfected or sterilized before further handling. Aim of this study was to determine effect of autoclave sterilization on the time dependent dimensional stability of vinylsiloxanether impression material. Impressions of stainless steel die (ADA/ANSI specification No. 19), were made of Vinylsiloxanether. Out of 40 specimens, half were allotted to group A and were autoclaved at 134°C AND 20 psi for 5 minutes. Rest of the specimens (Group B) served as a control. Dimensional changes were calculated for two time intervals i.e. after one hour and after twenty-four hours. Samples were scanned and images were analyzed by using Adobe reader XI (AcroRd 32) software. Paired t-test showed significant difference (p = 0.007) between readings at first hour (-0.047%) and twenty fourth hour (0.084%) in group A. Whereas independent t-test showed no significant difference in group A and B for both time intervals i.e. at first hour (p = 0.162) and twenty fourth hour (p = 0.148). It was concluded that Vinylsiloxanether can be sterilized in an autoclave without any deleterious change in dimensions.

Key Words: Vinylsiloxanether, Autoclave sterilization, Elastomers, Dimensional stability.

INTRODUCTION

One of the commonest procedures that can lead to transmission of infection between patients and laboratory technicians is dealing with dental impressions. Apart from general dental practice, prosthodontic procedures are gaining more affirmation regarding pathogenicity of hepatitis B virus (HBV), herpes, tuberculosis (TB), acquired immunodeficiency syndrome (AIDS) and pneumonia. Human Immunodeficiency Virus (HIV) related oral abnormalities are present in 30-80% of the HIV-infected individuals and few of the lesions are said to be contagious. HBV and HIV can persist viably on non-living surfaces for more than a week. Seventy two percent of the dental impressions receiving at laboratories yielded growth of bacteria, with a median number of 130 colony forming units (CFU). Therefore, microorganisms from the oral cavity are able to survive on the surface of impression material and are thus can contaminate the cast.

Rinsing with water, disinfection and sterilization are the various methods in use for cross infection control. Rinsing dental impressions under water is not sufficient for the removal of pathogens. Disinfection of the impression materials is strongly advised by American Dental Association (ADA) and Centres for Disease Control (CDC). Disinfection methods effects the dimensional stability of the impressions, thus it remained a subject of interest for many researchers, who used variety of approaches. Inability of disinfection procedures to destroy bacterial spores makes autoclaving the more desirable method for sterilization.

Amongst the variety of impression materials available, Addition silicone (Vinyl polysiloxane) is very well known for their excellent dimensional stability and precise detail reproduction. The storage temperature recommended by manufacturers, for dental impressions is 15-23°C Where as addition silicones remained stable at 134°C without any significant change in its dimensions. Where as their inherent hydrophobic nature and low tear strength are the chief drawbacks associated with addition silicones. On the other hand Polyether impression materials are hydrophilic and...
stable materials but they are quite expensive, bitter in taste and have high elastic modulus.\textsuperscript{16} A new elastomeric impression material, Vinylsiloxanether was introduced in early 2009 which combines the countenance of addition silicone and polyether impression material.\textsuperscript{19, 20}

Autoclaving of elastomeric impression materials is a new idea which will help in attaining complete sterility, thus will lend a hand in eliminating one of the causes of cross contamination among laboratory personnel and a standard protocol will be advised to break the cycle of indirect transmission of infection through dental impressions. This study will focus on the time dependent changes in dimensions of Vinylsiloxanether after being autoclaved. As there is lack of published work on this material, it provides an extensive range for further inquiry.

\textbf{METHODOLOGY}

A metallic test block was fabricated according to ADA specification number\textsuperscript{19} and International Standards Organization (ISO) Standard 4823 designed for the evaluation of Non-Aqueous, Elastomeric Dental Impression materials.\textsuperscript{21} It consisted of three parts: Ruled block, impression material mold and riser (Fig 1).

Vinylsiloxanether (Identium® - Kettenbach, Germany) elastomeric impression material having type 2 medium-bodied consistency and fast setting type was used. Pre-packed Cartridge (1:1, 50ml, Identium®-Kettenbach, Germany) along with the static mixing tip was loaded into the auto mix cartridge dispenser (1:1 - 3M ESPE). Mold was filled with mixed material extruding from the mixing tip in a zigzag pattern, Where as the tip remained buried in the material to avoid air entrapment. It achieved in \(\leq 45\) seconds, i.e. the working time recommended by manufacturer. After that mold was covered immediately with polyethylene sheet followed by a glass slab (weighing 75 \(\pm\) 5 grams), plus a 500g weight, was placed over it to standardize the pressure on the impression material during setting. Assembly was then transferred into a water bath (Zhengji HH-S4 Jiangsu, China) maintained at 32 \(\pm\) 2\(^{\circ}\)C (open mouth temperature) and allowed to set. Riser was used to remove the recorded impression from the mold. Total 40 impression specimens were prepared and divided into two groups each containing twenty specimens (\(n=20\)). Where \(\alpha = 0.05\) and power = 80. \textsuperscript{22} Specimens having all three lines recorded continuously for the full length of 25 mm between cross lines were included in the study. Where as those having air bubbles / voids incorporated in 20\(\mu\)m wide line, were excluded.

Specimens of group A were washed under tap water for 10 seconds and allowed to dry. They were then packed in 57mm x 130mm self sealing sterilization pouches (A.R. Medicom Inc. Hong Kong) and were steam sterilized in an autoclave (Glow Pak International, S. No. 487, Italy) at 134\(^{\circ}\)C and 20psi for 5 minutes.\textsuperscript{23} Specimen of Group B (control group) were only washed under tap water for 10 seconds and dried. All specimens were stored for twenty-four hours in moisture free, transparent polyethylene bags at room temperature of 28 \(\pm\) 2\(^{\circ}\)C.

Digital pictures of all the specimens were obtained by using scanner (HP DeskJet 2050 J510),\textsuperscript{10} at three time intervals i.e. soon after their making, after one hour of intervention and after twenty-four hour storage period. The resolution of 600dpi (dots per inch) was used. Images were analyzed by Adobe reader XI (AcroRd 32) software.\textsuperscript{24} Distance between the crosslines (\(cd\) and \(c'd'\)) was measured with accuracy of 0.01 mm. Data obtained were analyzed by SPSS version 16 software. A statistical tool was applied to evaluate data at 95\% confidence interval (P value \(\leq 0.05\)). Paired student’s t-test was applied to determine difference between mean initial and final values of each group separately. Intergroup comparison was done by using independent t-test.

\textbf{RESULTS}

Specimens of Group A showed mean dimensional change of -0.04710\% after one hour of autoclaving and 0.08495\% after twenty four hours. Group B mean dimensional change of 0.04235\% and -0.00320\% was observed for same time intervals respectively (Fig 2). Paired T test was applied to group A and B to determine changes in linear dimensions before and after autoclaving at one hour and twenty four hours interval (Table 1). Percentage dimensional changes at two different time intervals i.e. at first hour (-0.047\%) after autoclaving and at twenty fourth hour (0.084\%) showed a statistically significant difference (p = 0.047).

\begin{figure}[h]
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\includegraphics[width=\textwidth]{figure1.png}
\caption{Section A-A: Ruled block, section B-B: impression material mold, section C-C: Riser (*All measurements are in milimeters)}\textsuperscript{21}
\end{figure}
Dimensional stability of vinylsiloxanether

Among presently available dental impression materials, the dimensional stability and accuracy of addition silicone and polyether is widely accepted.25,26 Vinylsiloxanether is the hybrid of addition silicone and polyether elastomeric impression materials; therefore we discuss the parent components.27

Present study evaluated Vinylsiloxanether material for time dependent linear dimensional change after autoclave sterilization. Dimensional change is discussed between percentage dimensional changes at twenty-four hours (p = 0.148).

DISCUSSION

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TABLE 2: INDEPENDENT T TEST FOR PERCENT DIMENSIONAL CHANGE BETWEEN GROUP A & B

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0.007). Percentage dimensional changes at different time intervals i.e. at first hour (0.042%) and at twenty fourth hour (-0.003%) for control group showed no statistically significant difference (p = 0.407).

Independent T test was applied for inter group comparisons (Table 2). Percentage dimensional changes at one hour were compared between group A and group B, the difference was not statistically significant (p = 0.162). Similarly no significant difference was found in terms of expansion and shrinkage along with the accuracy of samples. In this study Vinylsiloxanether was found to be dimensionally stable after autoclaving.

Group A showed shrinkage of specimens, when observed after one hour of autoclaving. Results were consistent with the study of Ramakrishnaiah et al in which the polyvinylsiloxane showed contraction after autoclave sterilization. According to their study shrinkage was attributed to the loss of chemical con-
stiffents from the elastomers when subjected to high temperature of autoclave.\textsuperscript{11} Generally polymerization shrinkage, loss of volatile components, loss of water, and lack of elastic recovery are considered the main reasons for contraction in elastomeric materials.\textsuperscript{19}

Specimens in Group A showed expansion after 24 hours. Nissan et al explained that this expansion was due to the environmental factors as the polyether material (Impregum) expanded during storage.\textsuperscript{28} Megremis et al reported alteration in dimensions of an impression material because of storage temperature and humidity factor.\textsuperscript{29} During 24 hours storage period average ambient humidity was 63.6%. Variations in environmental humidity lead to loss or gain of water by the material e.g. in polyethers due to their hydrophilic nature, according to Mandikos et al.\textsuperscript{30} Endo and Finger studied effect of humidity (0%, 33%, 50%, 75%, and 100%) on the dimensional accuracy and found that polyether materials were significantly affected by raise in humidity level Where as addition silicones had no adverse effects on their dimensions.\textsuperscript{31}

Jacob et al noticed expansion of polyether impression material under dry condition.\textsuperscript{32} Where as Walker et al found no expansion of polyether impressions under moist condition.\textsuperscript{33} Therefore Jacob et al concluded that expansion of polyether impression material appeared to be material dependent, i.e. significant differences in formulations were found in different polyether impression materials being marketed even by the same manufacturer.\textsuperscript{32}

Following the ADA specification, the acceptable dimensional change for non – aqueous elastomeric impression materials is ≤0.5%.\textsuperscript{21} In our study results of the autoclaved specimens (group A) showed shrinkage of -0.047% after one hour of autoclaving. After twenty-four hours of autoclaving same specimens showed expansion of 0.085%. Ramakrishnaiah et al noticed dimensional changes in ADA acceptable range for polyvinylsiloxane after autoclaving at 134°C for 5 minutes and 20 psi pressure.\textsuperscript{11} Similar results were derived for poly vinylsiloxanether in this study.

The accuracy and dimensional stability of addition silicones after 18 minutes autoclaving at 134°C has been proved by Reddy SM et al.\textsuperscript{17} Surendra et al found no significant dimensional change after autoclaving of elastomers but suggested to delay pouring for twenty-four hours after autoclaving.\textsuperscript{34} In the light of results obtained from experiment group A, autoclave sterilization of vinylsiloxanether can be suggested without having any adverse effects on dimensional stability and accuracy of the impression recorded.

There was no statistical difference between Group A and B at one hour and twenty-four hours. Non-significant changes in dimensions of addition silicones were also observed after autoclaving by Xu et al\textsuperscript{37} and Surendra et al.\textsuperscript{34} The only significant difference was found between one hour and twenty-four hours dimensions (P=0.007) but this difference was within the acceptable range of ADA specification as also been previously concluded by Surendra et al.\textsuperscript{34}

Purk et al found clinically significant change in dimensions of addition silicones in comparison to polyether when evaluated at different storage temperatures e.g. -10, 24 and 66°C.\textsuperscript{35} Corso et al studied effect of temperature changes on the dimensional stability of polyvinylsiloxane and polyether. Storage of both materials at 4°C for 24 hours and then allowing them to attain room temperature showed slight expansion which was partly compensated by polymerization shrinkage. Polyether impression material showed slight expansion from 40°C to room temperature.\textsuperscript{36}

CONCLUSION

Within the limitations of this study it was concluded that Vinylsiloxanether remained dimensionally stable after autoclave sterilization. Though a significant difference was found between dimensions at one hour and twenty four-hours, but still they meet the requirements for dimensional stability by ADA specification number 19.

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