ORIGINAL RESEARCH

Effect of Disinfectants on Dimensional Stability of Two Elastomeric Impression Materials: An *In Vitro* Study

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Abstract

Aim: The aim of the current research was to evaluate the results of two different disinfectants on the dimensional stability of two elastomeric impression materials.

Materials and methods: A total of 120 samples were prepared in the present study. In accordance with the American Dental Association (ADA) specification number 19, a uniform stainless steel master die was constructed. In the current research, Imprint™ impression materials such as vinyl polysiloxanes (VPS) as well as a polyethers (PE), Impregum™, were used and manipulated as per the manufacturer's recommendations. To accomplish disinfection, 60 samples of either material were procured and allocated at random to one of the three groups: control group, 2% glutaraldehyde (GA) group, and 5.25% sodium hypochlorite (NaOCl) group. A stereomicroscope with 20× magnifying power was employed in the evaluation of the dimensional stability along with the aid of image investigation software.

Results: In VPS impression material, most dimension-related changes were noted with control group at 0.80 ± 0.02 in pursuit by 2% GA use at 0.43 ± 0.08. The lowest changes in the dimensions were noted with 5.25% NaOCl use at 0.36 ± 0.01. In PE impression material, most dimension-related changes were noted with control group at 0.84 ± 0.09 in pursuit by 2% GA use at 0.49 ± 0.05. The lowest changes in the dimensions were noted with the use of 5.25% NaOCl group at 0.43 ± 0.05. The differences amid the groups using ANOVA were found to be statistically significant with a p <0.001.

Conclusion: The results of this research indicate that either of the two elastomeric impression supplies that is VPS and PE showed little dimensional changes when subjected to immersion in two different disinfectants. Prolonged storage of samples disinfected with 5.25% hypochlorite and 2% GA may be utilized in the clinical set-up as the ensuing dimensional changes that result are quite less.

Clinical significance: Infection control has raised a significant alarm for the dental practitioner lately due to increasing communicable diseases. A route of possible infection could be through dental impressions that on being taken out of the mouth get laced with microbes present in the patient's saliva as well as blood. Therefore, it is necessary to identify an appropriate disinfectant that would have lowest unfavorable effect on the dimensional exactness of elastomeric impression materials.

Keywords: Dimensional stability, Disinfectant, Elastomeric materials, Impression.

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Introduction

A steady hazard to the dental practitioners is the infectivity of the operational environment with multiple pathogens that comprise the microbial flora of the mouth. Multiple sources indicate the pathogenicity and burden of disease-causing viruses such as hepatitis B, herpes, tuberculosis, and acquired immunodeficiency syndrome in the dental practice.[1]

The making of an impression is a technique that is often practiced in dentistry and mandates selecting apt impression materials and methods for a particular process.

After impression-making, casts are procured from the same that are employed as dies/study models to fabricate various appliances, indirect restorations, and prostheses. An impression that has set serves as a large resource for microorganisms that comprise bacteria, viruses, and fungal organisms that are retained after being taken out of the patient's oral cavity. In due course, these pathogens are transported to dental plaster and stone as the models are fabricated. Eventually, these models that harbor the pathogens pose the peril of transmitting infection to dental practitioners, personnel involved in transportation and laboratory personnel through indirect contact.[2]

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Therefore, it has been recommended by the ADA that dental labs and clinics pursue apt disinfection code of behavior put forth by the Center for Disease Control to avoid cross infectivity amid the dental practitioners, patients, and lab technicians.[3] Numerous ways of disinfection may be employed to purify different impression supplies. A frequent technique is chemical disinfection, in which the surface of the impression is subjected to chemical treatment via spraying/immersion. Several chemical disinfection agents are commercially available in various compositions and

concentrations.[4] Such chemical agents used for disinfection may be largely categorized into three types: high-level GA, intermediate NaOCl, and low-level chlorhexidine. GA (2%) as well as NaOCl (0.5%) are employed frequently for disinfection of elastomeric impression materials.[5]

Owing to suitable physical characteristics, elastomeric impression materials are usually preferred. One noteworthy property upon taking out the material from the oral cavity is the elastic revival of the impression material in the absence of deformation. Additionally, the substance must exhibit dimensional stability while disinfection as well as at the time of storage until the cast is poured. Thus, it is vital that the dimensional changes in the impression material are restricted to allowable variations of 0–0.15%.[6] Consequently, the current research was performed to evaluate the effect of 2% GA and 5.25% NaOCl disinfectants on dimensional stability of VPS and PE elastomeric impression materials.

Materials and Methods

The present study was conducted in Huraymala General Hospital, Majmaah, Kingdom of Saudi Arabia. A total of 120 samples [60 samples from VPS material and 60 samples from PE material] were prepared in the present study. In accordance with the ADA specification number 19, a uniform stainless steel master die was constructed.[7] The master die was composed of a ruled block measuring 31 mm height and 38 mm width as well as a mold ring. A step of size 3 mm height and 29.97 mm diameter was made along the die sides along which the metallic mold ring engages. The outer ring has a size of 38 mm, inner ring of 30, and 6 mm height that engages along the edges acting as a mold for the impression material. Water was used in ultrasound for two phases followed by placement in an oven at 37°C for 15 minutes before creating the samples. Two vertical lines, d1 and d2, 25 mm away from each other as well as three horizontal lines, A, B, C, were imprinted on the metallic die.

In the current research, Imprint™ Impression Material (3M ESPE™, Seefeld, Germany) such as VPS (60 samples) as well as a PE and Impregum™ (3M ESPE™, Seefeld, Germany) (60 samples) were used.

An automatic mixer Pentamix 2 (3M ESPETM, Seefeld, Germany) was employed to manipulate the VPS as well as the PE as per the manufacturer's recommendations. The mix thus procured was positioned in the ring-matrix assemblage. Following this, placement of a nonflexible metallic plate wrapped in an ethylene sheet on the assemblage was accomplished to ascertain a tight seal of the substance in the metallic matrix. In order to subject the material to a steady force while being set, as well as to simulate the operator forces during impression making, a 2 kg weight was positioned on the sheet. This assemblage in totality was subjected to immersion within a water bath at 35°C to replicate the oral temperature. An additional 3 minutes were given beyond the setting time implicated by the manufacturer for the PE—3: 15 minutes and VPS—2: 30 minutes together to make certain a whole polymerization of either substance.

To accomplish disinfection, 60 samples of either material were procured and allocated at random to one of the three groups:

Control group: The samples (VPS—20 samples and PE—20 samples) in this group were not exposed to any form of sterilization or disinfection practice.

2% GA group: Chemical disinfection was performed by immersing the samples (VPS—20 samples and PE—20 samples) for in 2% GA solution (Glutaron, Rio Química Ltda, Rio de Janeiro, Brazil) for 30 minutes.

5.25% NaOCl group: Chemical disinfection was performed by immersion of the samples (VPS—20 samples and PE—20 samples) in NaOCl solution at 5.25% (Soda Clorada/Inodon, Porto Alegre, Brazil) for 20 minutes.

After this time period described, the samples were washed again for 15 seconds in running water and air-dried. A stereomicroscope at 20× magnification was employed for assessment of the dimensional stability along with the aid of image investigation software to calculate the distance of line C amid lines d^1 and d^2 on the metallic die (L_1 = 25 mm), a comparable dimension was performed on the impression discs as well (L_2). Every dimension was measured by the same investigator as well as in similar situations. Calculation of any dimensional changes was accomplished as under:

$$\Delta L = 100 \times [(L_1 - L_2)/L_1]$$

Here, L_1 and L_2 stand for the distance amid lines d^1 and d^2 on the test die as well as on the impression material, correspondingly.

Statistical Analysis

IBM SPSS Statistics software—version 20.0 was used to analyze the data. Three-way mixed ANOVA statistical test was employed. The level of significance was set at $p < 0.05$ to interpret the occurrence of differences of statistical significance or statistically significant relations among groups.

Results

The mean dimensional stability prior to and following disinfection using VPS impression material is depicted by Table 1 and Figure 1. Most dimension-related changes were noted with control group at 0.80 + 0.02 (before immersion 0.15 + 0.11 and after immersion 0.95 + 0.13) in pursuit by 2% GA use at 0.43 + 0.08 (before immersion 0.19 + 0.06 and after immersion 0.62 + 0.14). The lowest changes in the dimensions were noted with 5.25% NaOCl use at 0.36 + 0.01 (before immersion 0.20 + 0.10 and after immersion 0.56 + 0.09). The differences amid the groups using ANOVA were found to be statistically significant with a $p < 0.001$.

The mean dimensional stability prior to and following disinfection using PE impression material is depicted in Table 2 and Figure 2. Most dimension-related changes were noted with control group at 0.84 + 0.09 (before immersion 0.14 + 0.10 and after immersion 0.98 + 0.19) in pursuit by 2% GA use at 0.49 + 0.05 (before immersion 0.20 + 0.12 and after immersion 0.69 + 0.17). The lowest changes in the dimensions were noted with the use of

Table 1: Evaluation of the mean dimensional stability before and after disinfection in vinyl polysiloxanes impression material

Groups	*n*	*Before (mean ± SD)*	*After (mean ± SD)*	*Dimensional changes*	*F-value*	*p-value*
Control group	20	0.15 ± 0.11	0.95 ± 0.13	0.80 ± 0.02	6.178	0.001
2% glutaraldehyde group	20	0.19 ± 0.06	0.62 ± 0.14	0.43 ± 0.08		
5.25% sodium hypochlorite group	20	0.20 ± 0.10	0.56 ± 0.09	0.36 ± 0.01		

5.25% NaOCl group at 0.43 + 0.05 (before immersion 0.18 + 0.08 and after immersion 0.61 + 0.13). The differences amid the groups using ANOVA were found to be statistically significant with a $p < 0.001$.

Tables 3 and 4 show the contrast of the mean dimensional stability of VPS as well as PE impression material subsequent to disinfection. No statistically significant differences were noted amid the impression resources as well as disinfectant groups.

Discussion

Elastomers when used as impression resources depict dimensional unsteadiness as a result of polymerization shrinkage discharge of byproducts from chemical interactions, thermal variations, or partial elastic revival after deformation. Impressions that get laced with salivary/blood components serve as a reservoir of microbes and source of possible contamination amid the dental clinic and laboratory employees. Appropriate usage of the dental impressions between the office employees as well as among the dental office and lab employees must be an indispensable portion of the infection control procedure. Sterilization leads to destroying of all types of microorganisms while disinfection causes annihilation of definite disease causing pathogens.[8]

As recommended by ADA Specification No. 19 for elastomeric impression supplies, a stainless-steel mold was employed to create disc-shaped impression samples for gauging the dimensional changes. This technique permitted indistinguishable replication of test circumstances so that fellow investigators can compare with new resources by using similar research settings. As per ADA Specification No. 19, intricate aspects of the 20 µm line in the metallic die should be replicated in the elastomeric impression supplies, as well as the linear dimensional changes must not be in excess of 1.5%.[9]

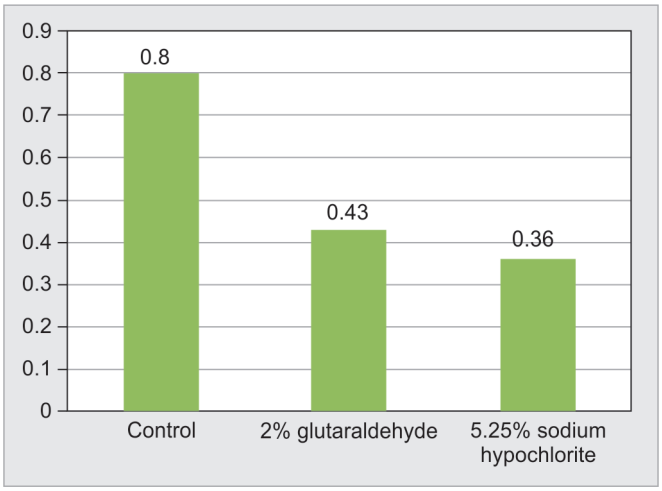

Fig. 1: Mean dimensional changes after disinfection in vinyl polysiloxanes impression material

Lack of unfavorable outcomes on the dimensional steadiness of impression materials was found by Kronstrom et al.[10] and Adabo et al.[11] Tullner et al.[12] also state that disinfecting impression materials do not lead to noteworthy modifications in their proportions. Lucas et al.[13] found from his research of either materials that disinfecting dental impressions causes enduring advantages vs. impression materials not subjected to disinfection. Additionally, samples disinfected by immersing in 5.25% NaOCl exhibited lower dimensional changes vs. control group as well as 2% GA use.

Likewise, Singh et al.[14] had comparable observations following disinfection with iodophor, NaOCl, GA, or double deionized water/when exposed to room air for 10 minutes. The researchers arrived at a conclusion that there are no unfavorable actions on the different impression materials with use of numerous medium employed in disinfection.

Success of therapy depends on critical parameters such as the dimensional precision and steadiness of the impression resources. VPS and PE impression substances are known to be superiorly dimensionally stable, though Shah et al.[15] and Faria et al.[16] reported PE to be more precise vs. VPS. In the research by Petrie et al.,[17] hydrophilic substances like VPS when utilized with a damp or soggy surface could not help in procuring a satisfactory impression at all times.

No statistically significant difference was found amid the VPS and PE when assessed comparatively prior to immersion. Subsequent to immersion striking different entities of statistical significance were noted among both substances in the control group. Additionally, PE exhibited greater shrinkage than VPS. The hydrophilic characteristics of PE can attribute to this finding.[18] Chen et al.[19] arrived at a conclusion that extended storage results in dimensional changes of VPS; nonetheless, these changes are lesser in comparison with that which takes place in other resources. Nassar et al.[20] evaluated the dimensional changes of two VPS materials as well as one PE Impregum™ Penta™ following 14 days of storage. They arrived at a conclusion that modifications in PE are more than in VPS; though, in either kind, such modifications are not clinically considerable. Walker et al.[21] assessed the dimensional constancy of a PE as well as VPS following disinfection subsequent to 14 days storage. They stated that PE exhibited significant dimensional changes following storage, while VPS depicted no significant dimensional changes.

The limitation of this study includes that it was performed in an *in-vitro* circumstances, making impressions and their removal which were not the same as impressions made in clinical practice. Stainless steel master die as well as the circumstances do not simulate the resiliency of dental tissues. Saliva plus soft tissues were not accounted for, as stainless steel model was used thereby neglecting these parameters in this research. More work on disinfection, sterilization, as well as storage environment of impression materials are necessary to ensure greater success of clinical procedures and cross-contamination prevention.

Table 2: Evaluation of the mean dimensional stability before and after disinfection in polyethers impression material

Groups	*n*	*Before (mean ± SD)*	*After (mean ± SD)*	*Dimensional changes*	*F-value*	*p-value*
Control group	20	0.14 ± 0.10	0.98 ± 0.19	0.84 ± 0.09	7.319	0.001
2% glutaraldehyde group	20	0.20 ± 0.12	0.69 ± 0.17	0.49 ± 0.05		
5.25% sodium hypochlorite group	20	0.18 ± 0.08	0.61 ± 0.13	0.43 ± 0.05		

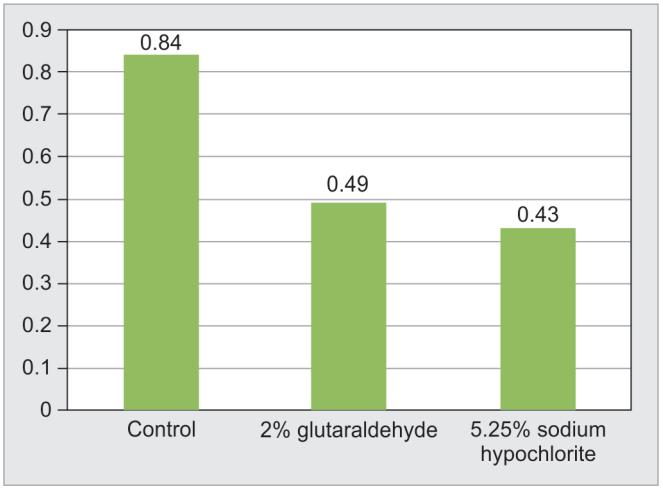

Fig. 2: Mean dimensional changes after disinfection in polyethers impression material

Table 3: Comparison of the mean dimensional stability of vinyl polysiloxanes impression material after disinfection

	Sum of squares	*Df*	*Mean square*	*F*	*Sig.*
Between groups	59.217	2	4.536	26.314	0.127
Within groups	497.168	40	1783.846		
Total	556.385	42			

Table 4: Comparison of the mean dimensional stability of polyethers impression material after disinfection

	Sum of squares	*Df*	*Mean square*	*F*	*Sig.*
Between groups	68.328	2	7.266	28.131	0.368
Within groups	597.319	42	2342.482		
Total	665.647	44			

Conclusion

The results of this research indicate that either of the two elastomeric impression supplies, that is VPS and PE, showed little dimensional changes when subjected to immersion in two different disinfectants. Prolonged storage of samples disinfected with 5.25% hypochlorite and 2% GA may be utilized in the clinical set-up as the ensuing dimensional changes that result are quite less.

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