Effects of Disinfectants on the Dimensional Stability of New-generation Monophasic Impression Materials

Dezenfektanların Yeni Jenerasyon Monofazik Ölçü Materyallerinin Boyutsal Stabilitesine Etkisi

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Abstract

Aim: In this study, we aimed to compare the effects of different disinfectants on the dimensional stability of four different monophasic vinyl polysiloxane (VPS) dental impression materials.

Materials and Methods: The four materials were used to simulate the master model impression and divided into four groups: Group E: Elite HD; Group H: Hydrorise; Group C: Compress mono; Group V: Variotime. Three study subgroups were planned for each material: the control, spray disinfection, and solution disinfection groups (n=10). Reference points of the specimens were measured every day during 7 days. One-way analysis of variance (ANOVA) and the Tukey HSD test were used for statistical analysis.

Results: Although no statistically significant difference was found between the length values of the materials after both 3 and 7 days (p>0.05), the highest dimensional change was observed in Group E and the lowest dimensional change in Group H, for all subgroups and all time intervals.

Discussion and Conclusion: Linear dimensional changes were seen in all groups, but the changes were clinically acceptable and within the ADA specification standards. Although no statistically significant difference was found between the impression materials, the highest dimensional stability was observed in Group H.

Keywords: dimensional stability; monophasic impression material; vinyl polysiloxane

Öz

Amaç: Bu çalışmada farklı dezenfektanların dört farklı monofazik vinilpolisiloksan dental ölçü materyalinin boyutsal stabilitesi üzerindeki etkilerini karşılaştırmak amaçlanmıştır.

Gereç ve Yöntemler: Söz konusu dört materyal ana model ölçüsünü elde etmek için kullanıldı ve dört gruba ayrıldı: Grup E: Elite HD; Grup H: Hydrorise; Grup C: Compress mono; Grup V: Variotime. Her bir materyal için üç alt çalışma grubu (kontrol, sprey dezenfeksiyonu ve solüsyon dezenfeksiyonu grupları) planlandı (n=10). Örneklerin referans noktaları 7 gün boyunca her gün ölçüldü. İstatiksel analiz için tek yönlü varyans analizi (ANOVA) ve Tukey HSD testi kullanıldı.

Bulgular: Üçüncü ve 7. gün sonunda materyallerin uzunlukları arasında istatistiksel olarak anlamlı bir fark görülmemekle birlikte (p>0,05), tüm zaman aralıklarında ve tüm alt gruplar dahilinde en yüksek boyutsal değişiklik Grup E'de, en düşük boyutsal değişiklik Grup H'de gözlemlendi.

Tartışma ve Sonuç: Tüm gruplarda lineer boyutsal değişiklikler gözlemlendi; ancak bunlar ADA standartları dahilinde ve klinik olarak kabul edilebilir düzeyde idi. Ölçü materyalleri arasında istatistiksel olarak anlamlı bir fark bulunmamasına rağmen en yüksek boyutsal stabilite Grup H'de gözlemlendi.

Anahtar Sözcükler: boyutsal stabilite; monofazik ölçü materyalleri; vinilpolisiloksan

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INTRODUCTION

The accuracy of dental impressions is the primary criterion for more successful prosthetic restorations. It depends on the dimensional stability, surface detail reproduction, and low deformation properties of the impression materials used. Since these parameters and the techniques preferred influence the detection of the location of the preparation finish line, they also directly affect the clinical success and prognosis of the prostheses (1–3). Recently, various types of vinyl polysiloxane (VPS) impression materials have been developed for better dimensional stability and surface details. They are commonly used to produce excellent final impressions in indirect restorations (4,5). In clinical practice, both mono- and dual-phase impression techniques can be used with these materials. The monophase impression technique is a single-step method that requires less chair time. Medium viscosity impression materials are used to record the finer details. On the other hand, the dual-phase impression technique involves two steps, such as heavy-body and light-body phases, to record the finer details (6,7).

Dental impression may be the first step of the excellent restoration. However, impressions can be contaminated with the patient's saliva and blood and thus be a source of cross-infection, which is a remarkable risk for dental practitioners, patients, and laboratorians (8–10). Procedures for preventing the transmission of contagious diseases such as AIDS, hepatitis, and tuberculosis are an important part of dental restorations (11,12). Of these, rinsing with pure running water is not sufficient for pathogen removal (13–15). As impression materials could be irretrievably altered with heat (16–18), high-heat sterilization is not an option either. Accordingly, many disinfection techniques have been proposed by researchers to limit the cross-contamination. Among these, spraying and immersion in disinfectant solutions are widely preferred due to their ease of use (19). A guideline for disinfecting impressions has also been issued by the American Dental Association (ADA). This guideline recommends use of a spray disinfectant or immersion in an ADA-approved disinfectant (20–22). Although these procedures can help with sterilization, it is not certain whether they also change the dimensional stability of impression materials, which is important for recording the fine details of the teeth and surrounding soft tissues (23–25).

The properties, quality, and accuracy of all new impression materials and their reactions to disinfection processes should be followed and frequently assessed for more successful prostheses. In this study, we aimed to evaluate the effects of spray and immersion disinfection procedures on the dimensional stability of four new monophasic VPS impression materials. The null hypothesis was that these disinfection procedures would not affect the dimensional stability.

MATERIALS AND METHODS

Four different monophasic elastomeric impression materials (Elite HD, Hydrorise, Compress mono, Variotime) were used to simulate the master model impression (Table 1).

The master model of the samples of the impression materials was produced according to the ADA Specification no. 19. A metal model (50x50x3 mm^3) consisting of two interlocking parts was used (Figure 1). There were vertical and horizontal lines on the model. The distance between the points D1 and D2 refers to the vertical dimension (25 mm) and the distance between the points A and C refers to the horizontal dimension (16 mm) (Figure 2).

The impression materials were mixed in the automixing machine (Zhermack Modulmix) according to the manufacturer's guidelines for faster and more homogeneous mixing. Then, they were poured in a metal model. A piece of glass (of 2-mm thickness) was placed on the upper part of the model for applying pressure to prevent gap formation and provide smooth surface. The excess materials were removed with a sharp-edged lancet.

Three subgroups were planned for each impression material: the control group, spray disinfection group, and solution disinfection group (Table 2). Each group contained 10 impression samples.

Disinfection procedures

No disinfection procedure was performed for the control group and the control samples were washed under running water for 30 sec. The samples of the second and third groups were rinsed under running water for 30 sec. After that, the second group samples

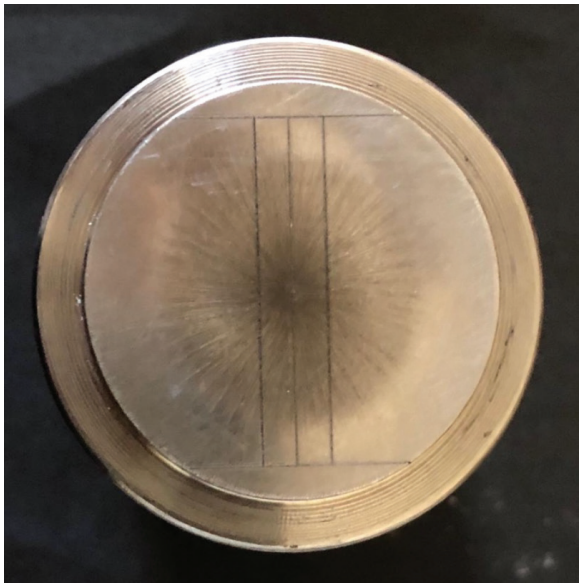

Figure 1. The metal model used

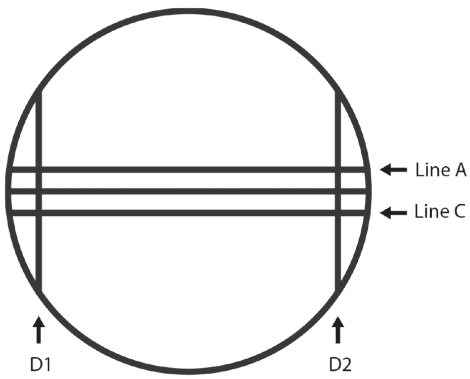

Figure 2. The vertical and horizontal dimensions

were kept in Zeta 7 Solution (%1 solution, 10 ml of solution was added to each liter of water) for 10 min. For the third group, Zeta 7 Spray was applied to the samples until the surface was completely covered, according to the manufacturer's guidelines. The contents of the disinfection agents are presented in Table 3.

After disinfection, the samples were stored in locked bags for 7 days. The length of the samples was measured every day according to ISO 4823 and with an XY travelling stage microscope (Cleveland, Prazisions-System, GmbH 79843 Löffingen, Germany; sensitivity of 0.01 mm) by the same operator.

Statistical analysis

According to the power analysis, a sample size of 8 was sufficient (α= 0.05; β=0.20). We used a sample size of 10 in the present study. One-way analysis of variance (ANOVA) and the Tukey HSD test were used to investigate the dimensional changes. The statistical analysis was performed using the SPSS 14.0 (SPSS Inc., Chicago, IL, USA) software.

RESULTS

For each impression material, ANOVA showed no statistically significant difference between the length values of the groups after both 3 and 7 days ($p>0.05$) (Table 4 and 5). Although there was no significant difference, the highest dimensional change was observed in Group E and the lowest change in Group H, for all time intervals ($p>0.05$).

DISCUSSION AND CONCLUSION

The accuracy and dimensional stability of VPS impression materials as popular tools among clinicians have been under continuous development (26). However, disinfection of these new materials is also crucial given the mentioned risk of cross-infection among patients, clinicians, and dental technicians (27). Accordingly, in this study we evaluated the dimensional changes of 4 monophasic VPS impression materials after spray and immersion disinfection.

The ADA has recommended use of surface disinfectants containing 5.25% sodium hypochlorite for spray disinfection and disinfectant solutions containing hypochlorite, iodophor, or glutaraldehyde with phenolic buffer for immersion disinfection (20,21). We used a new spray disinfectant (Zeta 7 Spray), which contains ethanol, 2-propanol, and an immersion disinfectant solution (Zeta 7 Solution) with dimethyl-didecyl-ammonium chloride and phenoxyethanol. Since the literature lacks sufficient data about the effects of disinfectants on the dimensional changes of monophasic VPS impression materials, this study has the potential of providing new information.

The dimensional stability of impression materials has been evaluated through either the impression material itself or measuring casts obtained from the impressions in previous studies (28,29). In this study, we performed an evaluation using the material itself to eliminate uncontrollable parameters such as the setting expansion of the plaster.

The control group impression materials were exposed to running water only, which is the simplest way to remove saliva and blood, and the dimensional changes were measured. After that, these values were compared with the dimensional changes measured after the spray and immersion disinfection procedures. The dimensional change can be affected by not only the properties of impression materials, but also the chemical composition of disinfectants and exposure time (18,30,31).

We found that neither spray nor immersion disinfection procedures had a significant effect on the dimensional stability of the elastomeric impression materials ($p>0.05$), which is consistent with the previously reported results (17,18,25,32,33). Therefore, the initial null hypothesis was accepted. However, it should be noted that there are also a few studies that indicate a negative effect of disinfection procedures on elastomers (34,35).

While Group E showed the highest dimensional change over all time periods ($p>0.05$), this value did not exceed the normal limit as stated earlier (7,36). On the other hand, Group H showed smaller changes in all conditions and time intervals. This could be explained by reactional differences of the components of the impression materials and disinfectants. In addition, the differences observed in the dimensional changes of the control group of each impression material show that, although they are the same type of impression material, the composition of the materials may not be the same, and that their initial shrinkage can be different.

There was a small and statistically insignificant difference between the dimensional changes due to the spray and immersion disinfection procedures in all VPS groups ($p>0.05$). The difference may be related to the components or alcohol percentages of the spray and immersion disinfectants. Additionally, uniform application can also differ with the two types. Immersion solutions spread on impression materials more homogeneously and may better prevent the elution of any byproducts.

Kronström et al. compared the dimensional changes of ring-opening metathesis elastomeric impression materials due to spray and immersion disinfection, and observed that spray disinfection caused more, but insignificant, changes than immersion disinfection

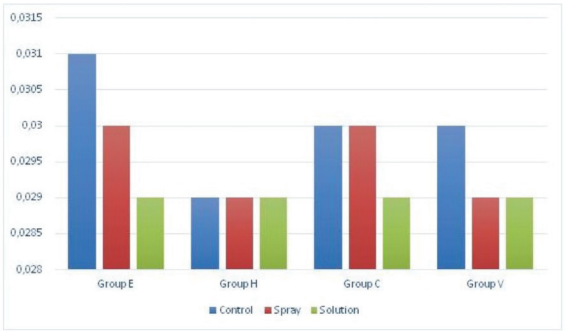

Figure 3. Bar graph for the 3-day results

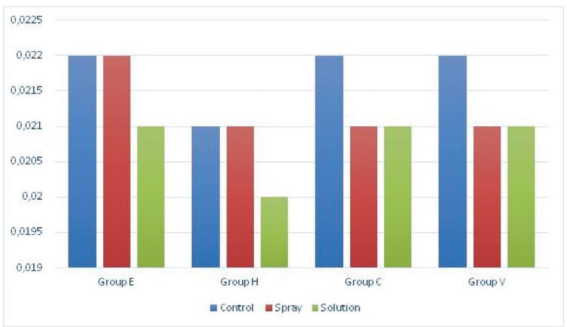

Figure 4. Bar graph for the 7-day results

in some surfaces with no undercut (37). This result is consistent with our study where we used a flat model with no undercut.

Tullner et al. stated that immersion disinfectants such as iodophor, 0.525% sodium hypochlorite, and 2% glutaraldehyde had no negative effect on different impression materials (38). Similarly, Matyas et al. (17) observed no adverse effects with different disinfectants and Kern et al. reported that neither spray nor immersion disinfection methods caused clinically significant problems of dimensional stability (39). These results are consistent with our findings.

Panichuttra et al. reported (40) that dimensional stability of all their VPS materials decreased between the 1-hour, 1-day and 1-week measurements. Although we also observed dimensional changes in all our monophasic VPS impression materials, these values were not clinically significant because they were below the ADA specification standard of ≤0.5% (41).

In conclusion, linear dimensional changes were seen in all monophasic VPS impression materials as a result of exposure to running water and the spray and immersion disinfectants. However, all dimensional changes were clinically acceptable values within the ADA standards. Group H showed the highest dimen-

Table 1. The materials used

Material	Type	Manufacturer	Technique	Viscosity
Elite HD	Polyvinylsiloxane	Zhermack, Italy	Automixing	Monophase
Hydrorise	Polyvinylsiloxane	Zhermack, Italy	Automixing	Monophase
Compress mono	Polyvinylsiloxane	Bisico, Germany	Automixing	Monophase
Variotime	Polyvinylsiloxane	Herause Kulzer, Germany	Automixing	Monophase

Table 2. The study groups (Group E: Elite HD; Group H: Hydrorise; Group C: Compress mono; Group V: Variotime)

Group E	Group H	Group C	Group V
Control	Control	Control	Control
Spray	Spray	Spray	Spray
Solution	Solution	Solution	Solution

Table 3. Contents of the disinfection agents used

Material	Manufacturer	Contents
Zeta 7 Solution	Zhermack, Italy	Quaternary ammonium salts, phenoxyethanol
Zeta 7 Spray	Zhermack, Italy	Alcohols

Table 4. The 7-day length values statistics (mean±standard deviation)

	Group E	Group H	Group C	Group V	p
Control	0.031±0.0024	0.029±0.0011	0.030±0.0015	0.030±0.0015	0.154
Spray	0.030±0.0012	0.029±0.0013	0.030±0.0017	0.029±0.0011	0.220
Solution	0.029±0.0020	0.029±0.0012	0.029±0.0032	0.029±0.0017	0.659
p	0.603	0.423	0.405	0.871	

Table 5. The 3-day length values statistics (mean±standard deviation)

	Group E	Group H	Group C	Group V	p
Control	0.022±0.0012	0.021±0.0007	0.022±0.0013	0.022±0.0013	0.343
Spray	0.022±0.0009	0.021±0.0001	0.021±0.0013	0.021±0.0008	0.406
Solution	0.021±0.0024	0.020±0.0011	0.021±0.0024	0.021±0.0016	0.682
p	0.267	0.413	0.262	0.131	

sional stability, although there was no significant difference between the effects of running water exposure and spray and immersion disinfection on the dimensional stability of the materials examined ($p>0.05$). Although our results were similar to those from previous studies, the present and previous studies are not comparable because each used different impression materials or disinfectants with different procedures. Also, our study has several limitations. First, we could not perform an exact simulation of the clinical realities of impression taking and removal and impression material deformation, for example. Secondly, dimensional changes were recorded on a flat surface, although the actual changes were three-dimensional. Finally, although disinfectants can be easily applied on surfaces without undercuts, it is difficult that they reach inside undercuts. Therefore, our results may be inadequate for real clinical conditions. Since the present study only evaluated the effects of different disinfectants on the dimensional stability of new impression materials, there is a need for further studies to investigate the biological, rheological and wetting properties and clinical acceptability of these materials.

Conflict of Interest and Financial Disclosure

The authors declare that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study.

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