Original Article

Effect of Three Disinfectants on Dimensional Changes of Different Impression Materials

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Abstract

Background and Aim: Disinfection of dental impression materials can alter their dimensional stability, which in turn can affect the accuracy of dental casts. This study aimed to determine the effect of three disinfectants on the dimensional changes of irreversible hydrocolloid impression materials and addition silicones.

Materials and Methods: In this in vitro experimental study, forty alginate and 40 addition silicone impressions were made using special trays. The impressions were disinfected by the spraying method for 10 minutes except for the control group. Then, they were poured with type IV dental stone. The prepared casts were maintained for 24 hours in a similar condition. Next, the dimensions and the external distance between two dies were measured at three time intervals using a digital caliper with 0.01 mm accuracy, and the average values were recorded. The yielded measurements were compared with each other and with metal models. One-way ANOVA and one sample t-test (α=0.05) were used for data analysis.

Results: No significant difference was observed between the groups ($P>0.05$). Comparison of all average dimensions of the casts with the metal model showed that none of the groups had a significant difference except for the alginate group that showed an increase in the height of the larger die. There was a significant difference in the rest of the dimensions ($P<0.05$).

Conclusion: Disinfection of alginate and addition silicone impression materials with 0.5% sodium hypochlorite, Epimax, and Deconex did not have any significant effect on the cast dimensions.

Key Words: Colloids, Dental impression materials, Dental disinfectants

➢ **Cite this article as:** Ghasemi E, Fathi AH, Parvizinia S. Effect of Three Disinfectants on Dimensional Changes of Different Impression Materials. J Islam Dent Assoc Iran. 2019; 31(3):169-176. DOI: 10.30699/jidai.31.3.169

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Received: 28 April 2019
Accepted: 10 Jul 2019

Introduction

Impression materials are used to make an exact duplicate of the hard and soft tissues in the oral cavity. Hydrocolloids and synthetic elastomeric polymers are among the most broadly used materials for taking an impression from dental arch (1,2). Each of these materials holds certain advantages and disadvantages. It is important to know the physical properties and limitations of impression materials for their successful use in clinical dentistry (3).

Disinfection of impressions is crucial since impressions can transmit viruses such as hepatitis B, HIV, and herpes simplex to dental stone models and consequently put dental laboratories and the operating personnel at risk (4). Different methods and materials have been proposed for disinfection of the dental casts, but considering the size variations in the impressions and subsequently their accuracy after disinfection, certain methods should be employed for their disinfection (5,6). Several

[DOI: 10.30699/jidai.31.3.169]

studies (7-12) have examined the effect of disinfection of dental impressions on their dimensional changes using different materials and methods. The results have mainly shown that disinfection of irreversible hydrocolloid impressions with disinfectants such as sodium hypochlorite does not significantly affect the dimensions of the obtained gypsum casts (13).

The results of a study that investigated the dimensional stability of elastomeric impression materials after disinfection showed that the dimensional changes in the condensation silicone and addition silicone impressions after immersion in sodium hypochlorite solution for the recommended time period were not clinically significant (14). Another study conducted on the dimensional accuracy of an irreversible hydrocolloid after disinfection with ozonized water showed that the accuracy of irreversible hydrocolloid impressions was not affected by immersion in ozonized water; however, spraying for 5 and 10 minutes resulted in smaller dies (15).

The amount of moisture and the time of disinfection are among other factors that can influence the dimensional stability of impressions (16). There are some studies about dental impression materials and their dimensional stability, including a study by Ghasemi et al, (17) on the effect of storage time on the dimensional changes of irreversible hydrocolloid impression materials and a study by Musharraf et al, (18) on the effect of storage time on the dimensional stability of irreversible hydrocolloid impression materials. Martin et al. (14) studied the dimensional changes of dental impression materials such as alginate, addition silicone, compression silicone, and polyether following immersion in disinfectants. Chew et al. (15) scrutinized the effect of employing water at a temperature range of 35-37°C, while Corso et al. (19) studied the effect of temperature on dimensional accuracy. Durr and Novak (20) evaluated the stability of full-arch alginate impressions immersed in one of two disinfecting solutions by measuring the stone casts poured from the alginate impressions. Statistically significant dimensional changes occurred although they were clinically insignificant (1 mm or less).

The present study aimed to assess the dimensional changes of casts produced from alginate and addition silicone impression materials disinfected with Epimax, Deconex and sodium hypochlorite (0.5%) by the spray technique to determine the effect of these disinfectants on alginate and addition silicone hydrophilic impressions.

Materials and Methods

In this in vitro experimental study, a steel model was used to study the dimensional changes of alginate impression material (Alginate Fast Set; Alginoplast, Bayer, Germany) and hydrophilic addition silicone (Panasil monophase medium; Kettenbach, Germany). This stainless steel model had a metal base measuring 100 × 65 × 15 mm and two abutments for a three-unit bridge (Figure 1). The study protocol was approved by the ethics committee of Isfahan University of Medical Sciences (391361).

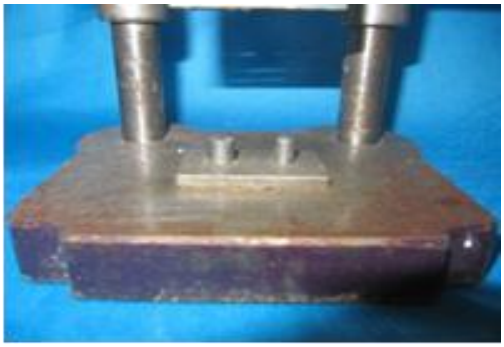

Figure 1. Metal model

Metal dies, in the form of incomplete cones with a round cross-section and 6° taper, were installed on the metal base. The diameter and height of the smaller die were 7.58 mm and 9.90 mm, and these dimensions for the larger die were 9.86 mm and 9.75 mm, respectively. The outer distance between the two dies was 31.43 mm. In one of these dies, a V-shaped groove was produced as an undercut below the finish line of the teeth in the cervical area (Figure 1). The

[DOI: 10.30699/jidai.31.3.169]

steel model also had a metal impression tray, which was not used in this study.

To produce the impressions, auto-polymerizing acrylic trays (Acropars 200, Medical Mar lick Industry, Iran) were fabricated on the model. To prepare these acrylic trays, three layers of red wax (Poly wax, Izmir, Turkey) were first placed around the dies to create a 4.5 mm space for the thickness of the impression material (alginate/addition silicone). Then, an impression was made from this model using Speedex (Asiashimi, Tehran, Iran) and the cast was poured with type III dental stone (Pars dental, Tehran, Iran). Subsequently, special trays were made with the same thickness. Ten specific trays were prepared, and some holes (2 mm in size with 10 mm intervals) were created in them (Figure 2). The paths of insertion and removal were limited by placing special edges on the bottom plate around the dies. To prepare the alginate impressions, appropriate amounts of powder were mixed with water in standard conditions. The mixing time and powder to water ratio were selected according to the manufacturer's instructions. The water temperature was 23°C, and mixed with the powder in a plastic bowl using a spatula. The metal model was prepared with the aid of a special tray. After 3 minutes, the impression was removed from the model. By using the special trays, 40 addition silicone impressions were made in four groups of 10. Each of these groups was sprayed with an antiseptic disinfectant, and 10 impressions were left without disinfection, and served as the control group. In order to make moderate-viscosity hydrophilic silicone impressions, acrylic custom trays were used to produce impressions from the metal model dies. After completion of setting, the casts were removed from the model. All the impressions were made in identical conditions and were washed with cold water for 15 minutes.

The alginate and hydrophilic addition silicone impressions were disinfected with Epimax (Emad pharmacy, Isfahan, Iran), Deconex (Borer, Switzerland), and 0.5% sodium hypochlorite (Shamin, Tehran, Iran) disinfectant solutions over a period of 10 minutes.

Figure 2. Special acrylic trays

Each impression was sprayed with the disinfectant (4 puffs each time) and then placed in a nylon pack with 100% relative humidity of the same disinfectant. For this purpose, a piece of gas, which was impregnated with the same disinfectant, was added to the same nylon pack.

After disinfection, the impressions were poured with type IV dental stone (Ernst Hinrichs GmbH, Goslar Germany IV). The plaster was first soaked in water for 10 seconds and mixed with a vacuum mixer (Multi Vac 4, Degussa, Berlin, Germany) at 100 rpm for 1 minute and 10 seconds of vibration [10]. After 45 minutes, the impressions were removed from the casts. The prepared casts were maintained for 24 hours in the same condition to completely dry. Then, a digital caliper (Mitutoyo Corporation, Japan) with 0.01 mm accuracy was used to measure the dimensions of the dies and their outer distance at three intervals, and the average values were recorded. The obtained values were compared with each other in different groups and with the metal model.

Statistical analysis of the obtained data was performed by SPSS version 16. The data were analyzed using ANOVA and one sample t-test (α=0.05).

Results

Comparison of the mean dimensional changes of the casts obtained from alginate and addition

[DOI: 10.30699/jidai.31.3.169]

silicone impressions in four groups of sodium hypochlorite (0.5 %), Deconex, Epimax, and control indicated that alginate and addition silicone impression groups had optimal dimensional stability and showed no significant changes (Table 1).

Comparison of the mean of different dimensions of alginate and addition silicone impression casts produced by the metal model showed that none of the groups had a significant difference except for the alginate group, which presented an increase in the height of the larger die (P=0.421 for sodium hypochlorite, P=0.183 for Deconex, P=0.232 for Epimax, and P=0.715 for the control group). There was a significant difference in the rest of the dimensions.

The absolute values of the percentage of change in the dimensions of the casts obtained from the alginate and additional silicone impressions with the metal model are presented in Table 2. The minimum percentage of change belonged to the casts obtained from the alginate impressions in the control group in the height of the large die and the maximum percentage of change occurred in the Epimax group in the big die diameter. The minimum percentage of change was in the casts derived from addition silicone impressions in the sodium hypochlorite group in the large die diameter, and the maximum percentage of change was observed in the control group in the height the small die.

Table 1. Comparison of mean dimensional changes in the casts obtained from alginate and addition silicone impressions using disinfectants for the two types of impression materials

Impression material Dimensions		Alginate	Addition silicone
The height of larger die	Sodium hypochlorite 0.5 Deconex Epimax Control	0.252±0.013	0.095±0.011
The height of smaller die	Sodium hypochlorite 0.5 Deconex Epimax Control	0.218±0.018	0.437±0.10
The diameter of the larger die	Sodium hypochlorite 0.5 Deconex Epimax Control	0.088±0.065	0.083±0.058
The diameter of the smaller die	Sodium hypochlorite 0.5 Deconex Epimax Control	0.633±0.034	0.120±0.001
The outer distance of the two dies	Sodium hypochlorite 0.5 Deconex Epimax Control	0.293±0.026	0.121±0.004

[DOI: 10.30699/jidai.31.3.169]

Table 2. Absolute values of the percentage of change in the dimensions of the casts obtained from the alginate and addition silicone impressions compared with the metal model

Dimensions Impression materials	Disinfectants	The height of larger die	The height of smaller die	The diameter of larger die	The diameter of smaller die	The outer distance of the two dies
Addition silicone	Sodium hypochlorite 0.5	0.8277±0.001	0.8182±0.005	1.4564±0.174	1.6253±0.001	0.7843±0.001
	Deconex	0.7758±0.033	0.9747±0.002	1.5639±0.018	1.1636±0.076	0.5927±0.002
	Epimax	0.8944±0.002	1.1040±0.001	2.5497±0.052	1.9274±0.002	1.0633±0.007
	Control	0.4738±0.004	0.8535±0.003	1.7627±0.037	1.3628±0.931	0.9565±0.001
Alginate	Sodium hypochlorite 0.5	0.7467±0.411	1.5040±0.001	0.1471±0.004	0.50±0.016	0.7381±0.03
	Deconex	0.6831±0.173	±0.271.637	0.5751±0.006	0.6280±0.050	0.4432±0.001
	Epimax	0.8872±0.132	1.1919±0.943	0.3935±0.001	0.5976±0.046	0.3525±0.006
	Control	1.3754±0.515	0.8162±0.007	0.6891±0.084	0.4535±0.315	0.4362±0.001

Discussion

Dental impression materials are used to accurately record the dimensions of oral tissues and their spatial relationships (21). A standard method to decontaminate the impressions is to wash them with water immediately after removing from the patient's mouth and disinfecting them. However, one of the most important problems of disinfection is dimensional changes of impression materials (22). For this reason, the effect of sodium hypochlorite (0.5%), Deconex, and Epimax disinfectants on alginate and addition silicone impressions was evaluated in this study.

Tan et al, (23) in their study on dimensional changes of casts made from irreversible hydrocolloids disinfected by the spray technique found that disinfection of alginate impressions with iodophor and phenol over a period of 10, 30 and 60 minutes by the spray method had no effect on the dimensional changes of the impression material. Despite the difference in the disinfectants, their results were consistent with ours. Hamedirad et al. (24) conducted a study on the dimensional stability of alginate impressions after disinfecting them with sodium hypochlorite (25.5%), Microtene, Deconex, and 2% glutaraldehyde by the spray and immersion techniques. They reported significant changes in the mean length and height between different groups and disinfection methods. In their study, the highest variation in the length of the dies was observed for Deconex (50.57 ± 0.10 mm) and the lowest value was recorded for Microtene (50.25 ± 0.20 mm) in the immersion method. Considering the changes in the height of the die, the highest value was reported for 2% glutaraldehyde and the lowest value was found for Deconex (20.02 ± 0.24 mm) in the immersion method. Hamedirad et al. (24) did not recommend the immersion method for disinfection of alginate impressions with Deconex, sodium hypochlorite, and glutaraldehyde. Therefore, it is better to disinfect the alginate impressions with Microtene, sodium hypochlorite, and glutaraldehyde by the spray method.

[DOI: 10.30699/jidai.31.3.169]

Disinfection by the immersion method can be used with Microtene (24).

In the present study, Deconex was used to disinfect the alginate impressions by the spray method, and no significant dimensional changes were observed. In the study by Hamedirad et al, (24) disinfection of the alginate impressions with Deconex using the spray and immersion methods caused significant changes in the dimensions ($P<0.05$). The difference between the results of the two studies could be due to the difference in the brand of the alginate impression material and the use of alginate glue. The results of spraying the impressions with sodium hypochlorite were consistent with the results obtained in the present study.

Melili et al. (25) conducted a study on the dimensional stability of two elastomeric impression materials after immersion in disinfectant solutions. They disinfected two impression materials, namely elastomeric polyether and addition silicone by immersion in disinfectant solutions of glutaraldehyde (MD250, MD) and Sterigum powder. The changes recorded in their study were not clinically significant and were within the scope of ADA standards (25,26).

In the present study, the percentage of alterations in addition silicone group was acceptable according to the ADA criteria (26). Hiraguchi et al. (27) investigated the dimensional variation and deformation of the casts of maxillary jaw models with antiseptic alginate impressions by applying 1% sodium hypochlorite and 2% glutaraldehyde disinfectants by the spray method. The results of their study showed that the differences in dimensional changes between the control group and the disinfected group were less than 24 µm, and no changes were observed in the plaster impressions (27). The overall results of their study were consistent with the results obtained in the present study.

Al-Omari et al. (28) examined the dimensional stability of reversible hydrocolloid impression materials, irreversible hydrocolloids, and polyvinyl siloxane disinfected with chlorhexidine solutions, phenolic compounds (C & J spray), and vicron (para) aldehyde materials. The results of their study showed that the alginate impressions immersed in chlorhexidine, if not immediately poured, exhibited significant dimensional changes. The impressions sprayed with phenol derivatives (C & J spray) for 20 minutes indicated significant dimensional changes both statistically and clinically. Addition silicone impression materials, regardless of the disinfection method, indicated slight variations, which were consistent with the results of the present study (28).

Suprono et al. (7) conducted a study on the effect of chloramine T disinfectant on alginate and addition silicone impressions. In their study, irreversible hydrocolloid impression materials had the largest linear dimensional variation. However, the linear dimensional variations in both impression materials were acceptable and in the range of ADA (0.1%) (7,26). Considering that the same materials and the same method (spray method) were used in the present study, the results obtained in the present study were similar to the results reported by Suprono et al (7).

Herrera and Merchant (29) conducted a study on the dimensional stability of dental impression materials after immersing them in disinfectant solutions. They used 0.5% to 1% sodium hypochlorite, 2% glutaraldehyde, and 16% neutralized and halogenated phenol to disinfect alginate impressions, addition silicones, polyether, and polysulfide. None of these disinfectants had a direct effect on the dimensional changes of the impressions, which is consistent with the results obtained in the current study.

Concerning the limitations of handmade trays, use of prefabricated metal model, and lack of in vivo environment, the results of this study confirmed that disinfection of the addition silicone impressions with 0.5% sodium hypochlorite, Deconex, and Epimax had acceptable clinical results. However, it is recommended to disinfect alginate impressions with 0.5% sodium hypochlorite and Deconex and it is not recommended (nor it is logical) to use Epimax.

Future studies are suggested to evaluate other

[DOI: 10.30699/jidai.31.3.169]

impression materials and disinfectants and the effect of other time intervals.

Conclusion

The results of the current study showed that the cast dimensions of alginate and addition silicone impressions in the four study groups had acceptable changes. This is while the alginate casts disinfected with Epimax were far from the ADA standards (dimensional variations of ≥ 1.0%).

Acknowledgement

This study was approved by the Research Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.REC: 3.361). This research was supported by Isfahan University of Medical Sciences Grant# 391361 and was based on a thesis submitted to the graduate school of Isfahan University of Medical Sciences in partial fulfillment of the requirements for the Doctor of Dental Surgery degree.

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[DOI: 10.30699/jidai.31.3.169]

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[DOI: 10.30699/jidai.31.3.169]