

# EFFECT OF DISINFECTANT SOLUTIONS ON THE WETTABILITY OF ADDITION SILICONE IMPRESSION MATERIALS AT TWO DIFFERENT EXPOSURE PERIODS- AN IN VITRO STUDY

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## Abstract

*Introduction: This study aims to evaluate the surface wettability of addition silicone impression materials, which were treated with two different disinfecting agents for two different time intervals.*

*Methods: Twenty-five rectangle-shaped specimens from each of two different addition silicone impression materials (Express GT and Flexceed) were prepared. Five samples from each impression material were kept as the control without any disinfection. The rest of the specimens were divided into two groups according to the disinfecting agents, (2% Glutaraldehyde and 0.5% sodium hypochlorite) and disinfected for two time periods (10 minutes, and 60 minutes). Later, surface wettability was tested and recorded. Data were analyzed with analysis of variance (ANOVA).*

*Results: The mean contact angle values of both impression materials at 10 minutes of disinfection were reduced when compared to the control group*

*(without disinfection). As the disinfection time increases there was a tendency of decreasing the contact angle for Flexceed and Express GT impression material for glutaraldehyde disinfectant. But for Flexceed, the mean contact angle values increased after 60 minutes of disinfection with sodium hypochlorite.*

**Keywords: Additional Silicone, Contact Angle, Disinfection, Wettability.**

## Introduction

Disinfection of dental impressions should be a routine procedure in the dental office and dental laboratory. Dental impressions are categorized under semi-critical objects in dental practice and require a high level/ intermediate level of disinfection or sterilization. The dental impressions are usually contaminated with saliva, plaque, and sometimes blood, all of which may carry pathogenic microorganisms. The impressions must be disinfected thoroughly to prevent cross-infection,

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after removal from the patient's mouth and prior to cast preparation, as recommended by ADA<sup>1</sup>.

Cross-infection control is of prime importance in dental practice but impression disinfection is still a widely neglected aspect<sup>2</sup>. The proper criteria for impression disinfection involve the most suitable method (spray or immersion) and appropriate application (time of contact). The factors to be considered for any disinfection protocol for dental impressions are the effectiveness, chemical stability, and efficacy of the disinfectant solution. The disinfection procedure should not alter the dimensions and surface details of the resultant casts or dies. It has been proven that the most effective method of reducing the burden of microorganisms from the impression surface is chemical disinfection. Spray disinfection and immersion disinfection are the two methods of impression disinfection. However, immersion is the most reliable method because all surfaces of the impression and tray come in contact with a disinfectant solution. But immersion is not the method of choice for hydrophilic impression materials<sup>3</sup>.

Vinyl Polysiloxane (VPS) impression materials are widely used for obtaining dimensionally accurate and stable models of oral structures, particularly in the production of inlays, crowns, and bridges<sup>4</sup>. Not only are VPS impression materials highly accurate and dimensionally stable, but they are offered in a wide range of viscosities for many applications and are easy to sterilize without harming the qualities of the material. Unfortunately, VPS impression materials are inherently hydrophobic, so they are susceptible to poor wetting of moist oral tissues and aqueous slurries of gypsum-based die materials (dental stone) resulting in casts and dies with pits and voids. Newer hydrophilic VPS impression materials have been developed to provide improved impression-making. Some manufacturers claim that the wettability of their VPS impression materials has been increased with the addition of new hydrophilic agents to the formulation. However, few have studied the effect

of various aqueous clinical disinfectants on the wettability of low viscosity, hydrophilic impression materials by dental stone slurries. The accuracy of the impression is affected by any change in surface reactivity as impressions are often treated with disinfectant to limit the transmission of diseases such as HIV and hepatitis B. Disinfecting dental impressions may affect the surface wettability of the impression material used<sup>4</sup>.

The wettability of the impression material can be evaluated by measuring the contact angle of a liquid droplet (distilled water) on the solid surface of the impression material. The contact angle is the angle formed between the surface of the wetted solid and a line tangent from the curved surface of the drop. As the angle increases, the wettability decreases. Low values indicate good wettability.

In this context, the present study is designed to evaluate the effect of two commercially available chemical disinfectants namely 2% Glutaraldehyde and 0.5% sodium hypochlorite on the wettability of addition silicone impression materials at different exposure intervals of 10 minutes and 60 minutes.

## Materials & Methods

It is an in vitro study conducted according to the guidelines of the local ethical committee of Govt Dental College, Thiruvananthapuram (IEC/E/27/2020/GDCT/Dated 06-01-2021)

Fifty specimens (75mm x 25 mm x 2mm) of two addition silicone impression materials were fabricated using a rectangular acrylic mold (Fig.1). For preparing the acrylic mold, self-cure acrylic was mixed and placed on a glass slab and a 75mm x 25 mm x 2mm microscope slide was pressed on it during the dough stage to create rectangular-shaped molds. The impression material was expressed onto the prepared mold using automatic mixing and dispensing device (Generic Dental Dentmax 3M) and a glass slab was pressed over it till the material was set to get a smooth and polished surface (Fig 2). Immediately after setting

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the specimens were retrieved and stored in airtight containers. Then the specimens were divided into two main groups as there were two impression materials used for the study. (Express GT light body (3M ESPE Dental Products U.S.A.) and Flexceed light body (GC India Dental Pvt Ltd)).

The specimens obtained from each impression material were randomly divided into five groups with five specimens in each group according to disinfectant type and duration of disinfection. (Fig 3 & 4) Five specimens from each group were set aside as control without any disinfection. The disinfectants 2% glutaraldehyde and 0.5% Sodium hypochlorite solution were studied for two exposure times, 10 minutes and 60 minutes.

Five specimens from each group were subjected to disinfection by spray method with 2% Glutaraldehyde (Cidex) and 0.5% Sodium hypochlorite (Nice) solution at intervals of 10, and 60 minutes. During the time of disinfection, specimens were stored in closed containers to avoid evaporation of disinfectant. Specimens were thoroughly washed with distilled water for one min, air dried, then stored again in closed containers. All specimens were coded for identification.

Contact angle measurements of the surfaces of all specimens were performed using a Dynamic Contact Angle analyzer (Data physics Contact Angle system). Each specimen was mounted on the adjustable mechanical stage of the Goniom-

TABLE 1. CONTACT ANGLES OF EXPRESS GT

Express GT	N	Contact angle			
		Mean	sd	Mean	sd
No Disinfection	30	72.73	2.35	72.73	2.35
		Disinfection with Glutaraldehyde		Disinfection with Sodium hypochlorite	
Disinfection 10 minutes	30	67.15	2.49	65.51	4.25
Disinfection 60 minutes	30	63.49	1.41	66.36	2.85

TABLE 2.MULTIPLE COMPARISONS

Multiple comparisons	mean difference	SE	p
No Disinfection VS Glutaraldehyde 10 minutes	5.57	0.8244	<0.001
No Disinfection VS Glutaraldehyde 60 minutes	9.24	0.8244	<0.001
No Disinfection VS Sodium hypochlorite 10 minutes	7.22	0.8244	<0.001
No Disinfection VS Sodium hypochlorite 60 minutes	6.37	0.8244	<0.001
Glutaraldehyde 10 minutes VS Glutaraldehyde 60 minutes	3.67	0.7373	0.273
Sodium hypochlorite 10 minutes Vs. Sodium hypochlorite 60 minutes	-0.85	0.7373	1.000

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eter. Using an installed needle, a drop of distilled water was released on the surface of specimens at room temperature. An optic device equipped with a high digital video camera was used to monitor the dropped water. Images were monitored until the drop of distilled water contacted the surface of the specimen (Fig. 5). The contact angle at six different areas of each specimen was recorded and expressed as mean ± standard deviation (Tables 1 & 3)

## Statistical Analysis

The statistical analysis was performed using IBM Statistical Package for Social Sciences (IBM-SPSS ver. 24). Two-way repeated measures analysis of

variance (ANOVA) test was used to compare contact angle measurements between the control, and experimental groups at different time intervals. A p-value of <0.05 is considered as statistically significant.

## Results

The contact angle of impression material was reduced following disinfection with Glutaraldehyde and sodium hypochlorite. When compared with the control group (No disinfection) the mean contact angle of Flexceed and Express GT decreased significantly (p= <.001) after disinfection with glutaraldehyde for time periods of 10 and 60 minutes. {TABLE 1}. When compared with the control group, the mean contact angle of Flexceed and

TABLE 3. CONTACT ANGLES OF FLEXCEED

Flexceed	N	Contact angle			
		Mean	sd	Mean	sd
No Disinfection	30	113.21	2.29	113.21	2.29
		Disinfection with Glutaraldehyde		Disinfection with Sodium hypochlorite	
Disinfection 10 minutes	30	108.69	3.68	109	3.82
Disinfection 60 minutes	30	103.65	1.81	110.4	2.16

TABLE 4 MULTIPLE COMPARISONS

Multiple comparisons	mean difference	SE	p
No Disinfection VS Glutaraldehyde 10 minutes	9.56	0.9064	<0.001
No Disinfection VS Glutaraldehyde 60 minutes	4.09	0.9064	<0.001
No Disinfection VS Sodium hypochlorite 10 minutes	4.52	0.9064	<0.001
No Disinfection VS Sodium hypochlorite 60 minutes	2.81	0.9064	0.024
Glutaraldehyde 10 minutes VS Glutaraldehyde 60 minutes	-5.48	0.756	<0.001
Sodium hypochlorite 10 minutes Vs. Sodium hypochlorite 60 minutes	-1.72	0.756	0.248



Express GT decreased significantly ( $p = <.001$ ) after disinfection with sodium hypochlorite at time intervals of 10 and 60 minutes. This demonstrates that surface disinfection has no adverse effects on the wettability of addition silicone impression material.

While comparing the mean contact angle (MCA) of Express GT and Flexceed impression material disinfected with glutaraldehyde and sodium hypochlorite at two different exposure periods (10 & 60 minutes), the specimens disinfected for 60 minutes with glutaraldehyde showed a decrease in contact angle values than those disinfected for 10 minutes and the values were statistically sig-

nificant. But disinfection with sodium hypochlorite exhibited an increase in contact angle even though the values were not statistically significant.

## Discussion

The possibility of transmission of communicable disease through dental impressions has been debated by researchers in the last few decades<sup>5</sup>. Glutaraldehyde and sodium hypochlorite has been recommended for dental impression disinfection in several studies.

Addition silicone is considered to be the best dimensionally stable impression material, but they

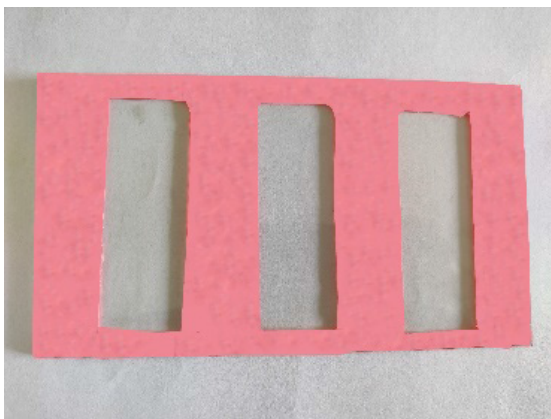


Fig 1, Acrylic mold



Fig 2. Sample preparation



Fig 4. Flexceed

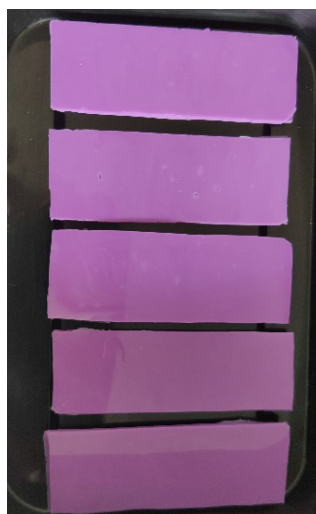


Fig 5. Express GT

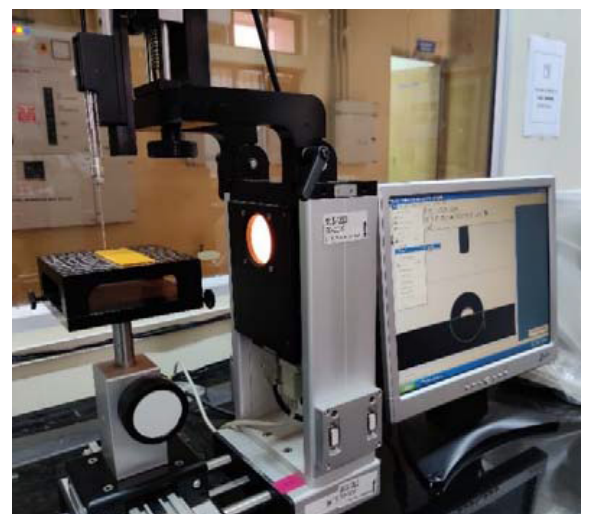


Fig 6. Contact angle testing in progress

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are inherently hydrophobic in nature. Usually, they are made hydrophilic by adding surfactants by the manufacturers. Surfactants (soap-like materials that provide enhanced wetting of hydrophobic surfaces by aqueous fluids) are added to some impression materials to provide better wetting of oral tissues and to enhance coverage with unset stone, thus decreasing the occurrence of bubbles in definitive casts.<sup>6</sup> Exposure of the set impression material to a liquid disinfectant may remove the surfactant, rendering the impression surface more hydrophobic and creating problems in obtaining bubble-free definitive casts<sup>7</sup>. The action of disinfectants on these surfactants is poorly studied. If the wettability is not proper, the resultant casts will be with lots of voids on their surfaces that can affect the dimensional accuracy. Several studies have been conducted to assess the effect of disinfectants on the surface wettability of dental impression materials.

In the present study, the mean contact angle obtained for Express<sup>GT</sup> material was found to be in the range of 65°-73° and for Flexceed, it was in the range of 100° to 113°. A liquid is considered to be wetting a surface when the contact angle is less than 90 degrees and is considered non-wetting when the contact angle is more than 90 degrees<sup>8</sup>. Thus an impression material is considered hydrophilic if the contact angle is less than 90 degrees. Here we have not compared the contact values between the two impression materials, but we compared how the contact angle values were affected by the two disinfectants with different duration of disinfection.

Immersion disinfection is the most popular way of disinfecting impressions, most likely because it is guaranteed that all surfaces of the impression and the tray will be contacted by the disinfectant. It has been found that immersion disinfection can alter impression materials by making them more or less wettable. It is suggested that the surface characteristics and chemical composition may

be affected during the disinfection procedure by diluting or absorbing the surfactant present in the impression material and by increasing the surface roughness<sup>9</sup>. Here we used spray disinfection in order to prevent the disadvantages of immersion disinfection.

In the present study, contact angle measurements of impression materials (Express GT and Flexceed) disinfected with 2% glutaraldehyde and 0.5% sodium hypochlorite spray for 10 minutes showed a significant reduction in contact angle when compared with the control group (without disinfection). This is in accordance with the study conducted by Lad et al who concluded that a 10-minute spray disinfection of silicone and poly ether impression using 2% Glutaraldehyde did not compromise their wettability<sup>10</sup>.

The contact angle measurements of express GT and Flexceed impression materials disinfected with 2% glutaraldehyde at 10 minutes and 60 minutes had decreased contact angle values with increasing exposure time. This result is in accordance with the study conducted by Al Zain in which the contact angle measurements of impression material subjected to disinfection were reduced as the measuring time was prolonged<sup>11</sup>. When the contact angle measurements of express GT and Flexceed impression materials disinfected with sodium hypochlorite at 10 minutes and 60 minutes were compared, there is a tendency of increasing the contact angle values with increasing exposure time. Increasing the exposure time of disinfection with sodium hypochlorite is not advantageous in terms of wettability and it supports the disinfection time of 10 minutes recommended by the manufacturers. This finding is commensurate with the study of John Blalock et al, which showed that the contact angle of a VPS surfactant containing impression material will increase as the duration of contact with a hypochlorite-based disinfectant was increased<sup>12</sup>.

Many studies investigated the wettability of impres-

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sion materials and the effects of different disinfection and surface treatments on the contact angle of impression materials. Lepe et al concluded that disinfecting low viscosity impression materials with 2% Glutaraldehyde for 30 minutes by the immersion method, exhibited a slight decrease in the wettability of impression materials<sup>13</sup>. Blalock et al used a hypochlorite-based disinfectant in their study and concluded that the wettability of both heavy and wash types of VPS impression materials decreased with increasing exposure times of the disinfectant. Kang et al preferred quaternary ammonium-based and chlorine based disinfectants for disinfecting VPS materials in their study and stated that the chlorine-based disinfectant was more advantageous in terms of wettability<sup>14</sup>.

Milward and Waters evaluated the effect of disinfection procedures on the wettability of VPS impression materials and reported that short-term disinfection by immersion significantly reduced wettability<sup>15</sup>. Kotha et al evaluated five different VPS materials in terms of chemical disinfection, autoclave sterilization, and microwave sterilization, and concluded that all three methods did not cause any significant difference in the wettability of the impression materials<sup>16</sup>. Al Zain investigated the wettability of VPS and polyether specimens, disinfected with 0.5% glutaraldehyde spray. In this study, impression materials disinfected with 0.5% glutaraldehyde were observed to have lower contact angles at 0.5, 1, and 2- minute measurement points than not disinfected specimens, and therefore 0.5% glutaraldehyde was recommended to use for disinfecting the tested impression materials. Lad et al concluded that disinfecting silicone and polyether impressions with 2% glutaraldehyde by a 10-minute spray did not cause a significant change in wettability.

The present study demonstrated that disinfection performed with 2% glutaraldehyde increased the wettability of two Vinyl polysiloxane impression materials at two different time intervals of disinfection.

But with Sodium hypochlorite, the wettability decreased with increased disinfection time.

Silicone impression materials are available in various consistencies. Only some of the low viscosity impression materials were evaluated in this study. It is unreasonable to expect similar results with various other brands of impression materials with various consistencies subjected to different immersion protocols with disinfectant solutions<sup>17</sup>. The objective of this study was only to evaluate the effect of disinfectant solutions on the wettability of addition silicone impression materials. Factors like dimensional changes and the effect of different concentrations of various disinfectant solutions on wettability were not investigated in the present study. Further research can be undertaken in this direction to overcome these limitations.

## Conclusion

Within the limitations of the study, the following conclusions can be drawn

1. The disinfection procedures have no pronounced effects on the wettability of addition silicone impression materials.
2. Disinfection with 2% glutaraldehyde increased the wettability of addition silicone impression material, whilst for 0.5 % sodium hypochlorite the wettability decreased with increasing exposure time, so the recommended time of disinfection prescribed by the manufacturer is important and is to be strictly followed.

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