An *In Vitro* Study to Compare the Surface Roughness of Two Polyvinylsiloxane Impression Materials Following Ultraviolet Irradiation or Chemical Disinfection

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ABSTRACT

Aim and objective: To evaluate and compare the surface roughness of two polyvinylsiloxane impression materials following ultraviolet irradiation and chemical disinfection.

Materials and methods: The surface roughness of two different polyvinylsiloxane impression materials (Elite HD+ and Aquasil) were evaluated following ultraviolet irradiation and chemical disinfection using a surface profilometer. Sixty specimens of each impression material were fabricated and divided into one control two experimental groups. The mean surface roughness values among the treatment groups were recorded and subjected to the statistical analysis.

Results: Both the materials showed a statistically significant increase in the surface roughness values following ultraviolet irradiation and chemical disinfection. In general, the control groups presented the least surface roughness and the chemical groups presented the maximum surface roughness values.

Conclusion: Ultraviolet irradiation sterilization of polyvinylsiloxane elastomeric impression materials resulted in a lower surface roughness and hence may be preferred over chemical disinfection.

Keywords: Chemical disinfection, Polyvinylsiloxane impression materials, Surface roughness, Ultraviolet irradiation.

International Journal of Experimental Dental Science (2020): 10.5005/jp-journals-10029-1215

INTRODUCTION

Impression materials in dentistry are used to register the form and relation of the teeth and the surrounding oral tissues. To prevent the possible spread of infectious diseases like HIV AIDS, Hepatitis B, etc., the American Dental Association (ADA) and the Centers for Disease Control (CDC) have recommended disinfection of dental impressions.^{1,2} A number of physical and chemical methods have been proposed for the disinfection of dental impressions. Physical action yields an increase in temperature, which may result in distortion of impression materials, and hence chemical disinfection is believed to be the simplest and an effective form of infection control. As per the ADA guidelines, the impression must be rinsed thoroughly to remove saliva, blood, and debris. This is followed by immersion in a disinfecting agent like glutaraldehyde, iodophor, or hypochlorite.³

Certain microbial forms, for instance, bacterial spores, are not eliminated by chemical disinfection alone. Hence, alternative methods have been introduced such as steam autoclave, microwave, ethylene oxide gas autoclave, gaseous ozone, and radiofrequency glow discharging.^{4,5} In recent years, ultraviolet (UV) radiation has become an effective way of disinfecting impressions as they are effective in destroying the microorganisms and the bacterial spores while preserving the quality of the material.⁶

The SARS-CoV-2 virus that has caused outbreaks globally has not yet been specifically evaluated for its vulnerability to ultraviolet irradiation. However, several studies on related coronaviruses, as well as the SARS coronavirus, have shown that they are greatly susceptible to ultraviolet radiation inactivation.⁷ An accurate impression of the dental tissues is a major requirement for the precise adaptation of the dental prosthesis. Polyvinylsiloxane

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How to cite this article: Farooqui R, Aras MA, Chitre V. An *In Vitro* Study to Compare the Surface Roughness of Two Polyvinylsiloxane Impression Materials Following Ultraviolet Irradiation or Chemical Disinfection. *Int J Experiment Dent Sci* 2020;9(2):52-55.

Source of support: Nil

Conflict of interest: None

elastomeric impression materials have excellent physical and mechanical properties and hence are the materials of choice for all impression procedures in dentistry.⁵

An impression with irregularities or surface defects may result in an ill-fitting prosthesis. In order to prevent plaque and calculus buildup and also improve esthetics, a smooth intaglio surface is desirable. Any irregularities on the intaglio surface of the prosthesis might influence its fit. Such irregularities may result from alterations in the material's properties following disinfection procedures.^{8,9}

The rationale of this study was to assess the outcome of chemical disinfection and ultraviolet irradiation on the surface roughness of two different polyvinylsiloxane elastomeric impression materials. The null hypothesis was that ultraviolet irradiation and chemical disinfection do not have any effect on the surface roughness of polyvinylsiloxane elastomeric impression materials.

Fig. 1: Metal matrix with impression material

Fig. 2: Specimens placed in an ultraviolet chamber

MATERIALS AND METHODS

Materials Used

Polyvinylsiloxane; light body (Aquasil Dentsply, Germany)
 Polyvinylsiloxane; light body (Elite HD+, Zhermack)
 Stainless steel metal matrix
 2% glutaraldehyde (CIDEX Johnson & Johnson company)

Equipment

Ultraviolet chamber (Thermo Electric Technologies, Bengaluru, India)

Surface profilometer (Bruker Contour GT-K; Bruker Nano, Berlin, Germany)

Method

A rectangular stainless steel metal plate with 15 cylindrical matrices (dimension 2 mm in thickness and 20 mm diameter) was used to fabricate the specimens. Two glass slabs one on the top and one below of the rectangular stainless steel plate were used (Fig. 1). This resulted in a standardized size of the test specimens and to retrieve them without deformation. A total of 120 specimens were fabricated with 60 specimens for each of the two polyvinylsiloxane impression materials used.

The base and accelerator pastes of each polyvinylsiloxane impression materials were dispensed and hand mixed as per the manufacturers' instructions. The mixed material was then placed in the matrices and smoothed using a spatula to standardize the thickness. The specimens were allowed to set in a thermostatically controlled water bath at 37°C. Following setting of the material, the specimens were carefully retrieved and stored at room temperature in zip-lock plastic bags.

The specimens were divided as follows:

Fig. 3: Specimens immersed in 2% glutaraldehyde

Group Ia and IIa (control): No sterilization was used.

Group Ib and IIb (UV radiation): Specimens were placed in an ultraviolet chamber for 10 minutes (Fig. 2).

Group Ic and IIc (chemical disinfection): Specimens were immersed in 2% glutaraldehyde for 10 minutes as per manufacturer's recommendations (Fig. 3).

Measurement of Surface Roughness

The surface roughness was measured at five randomly selected areas in each sample using a noncontacting optical surface profilometer (Bruker Contour GT-K; Bruker Nano, Berlin, Germany) and average value was recorded.

RESULTS

One-way ANOVA was carried out to compare the mean surface roughness among the different subgroups in group I (Elite HD⁺) and group II (Aquasil), respectively (Table 1). The surface roughness was found to be the highest in group Ic (0.540) and the lowest in group IIa (0.26745). The Tukey HSD test revealed that the difference

Table 1: Descriptive statistics for the surface roughness for different groups

Materials		N	Mean	Std. deviation	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
Elite HD+	Control	20	0.52035	0.003117	0.51889	0.52181	0.515	0.526
	UV radiation	20	0.52910	0.001334	0.52848	0.52972	0.527	0.531
	Chemical	20	0.54010	0.001917	0.53920	0.54100	0.537	0.544
	Total	60	0.52985	0.008443	0.52767	0.53203	0.515	0.544
Aquasil	Control	20	0.26745	0.002685	0.26619	0.26871	0.263	0.271
	UV radiation	20	0.28245	0.002625	0.28122	0.28368	0.279	0.287
	Chemical	20	0.29180	0.002285	0.29073	0.29287	0.289	0.295
	Total	60	0.28057	0.010417	0.27788	0.28326	0.263	0.295

Table 2: Comparison of the peel bond strength based on groups

						95% confidence interval	
Materials				Mean difference (I-J)	Sig.	Lower bound	Upper bound
Elite HD+	Tukey HSD	Control	UV radiation	-0.008750	0.000	-0.01046	-0.00704
			Chemical	-0.019750	0.000	-0.02146	-0.01804
		UV radiation	Control	0.008750	0.000	0.00704	0.01046
			Chemical	-0.011000	0.000	-0.01271	-0.00929
		Chemical	Control	0.019750	0.000	0.01804	0.02146
			UV radiation	0.011000	0.000	0.00929	0.01271
Aquasil	Tukey HSD	Control	UV radiation	-0.015000	0.000	-0.01693	-0.01307
			Chemical	-0.024350	0.000	-0.02628	-0.02242
		UV radiation	Control	0.015000	0.000	0.01307	0.01693
			Chemical	-0.009350	0.000	-0.01128	-0.00742
		Chemical	Control	0.024350	0.000	0.02242	0.02628
			UV radiation	0.009350	0.000	0.00742	0.01128

in the surface roughness values was statistically significant at 0.00 level ($p < 0.05$) (Table 2). In general, the control groups (group Ia and group IIa) presented the lowest surface roughness values and the chemical group (group Ic and group IIc) presented the highest surface roughness values.

DISCUSSION

This null hypothesis was rejected as there was a statistically significant difference in the surface roughness of the polyvinylsiloxane elastomers when subjected to chemical disinfection and ultraviolet irradiation. Generally, dental impressions are disinfected by immersing them in an appropriate disinfectant solution or by spraying. Spraying leads to pooling of the disinfectant solution and hence not effective in disinfection. Hence, the immersion method was used in this study. Previous studies have demonstrated that polyvinylsiloxane impressions can be effectively disinfected on immersion with 2% glutaraldehyde for 10 minutes. Glutaraldehyde acts by fixation of the cell membrane and blocking the release of cellular components, thus killing the microorganisms.³

Ultraviolet irradiation has shown to be an effective method of inactivating the microorganisms while preserving the quality of material. Ultraviolet light results in the formation of thymine-containing photoproducts in the DNA of affected cells. Studies have shown that the UV chamber can be safely used for the disinfection of the polyvinylsiloxane impression material without affecting its dimensional stability.^{10,11} The disinfection

procedure can result in change in the properties of the material leading to changes in the surface roughness. Several studies have evaluated the surface roughness of gypsum casts^{8,9,12} obtained from elastomeric impressions. Studies on the measurement of surface roughness directly on the impressions are inadequate.

A significant difference in the surface roughness was observed within the control group for the two materials. The Elite HD⁺ specimens showed higher surface roughness values compared to the Aquasil specimens, which may be due to differences in the chemical composition in addition to the size, shape, and amount of the filler particles. Both the chemically disinfected and ultraviolet irradiated groups showed increased surface roughness values; however, greater increase was found for the chemically disinfected groups.

Since studies on the evaluation of surface roughness of polyvinylsiloxane impressions are limited, direct comparisons with the results obtained in this study cannot be made. Since chemical disinfection has limited success, ultraviolet radiation may be considered as an alternative to sterilize elastomeric impressions. However, before arriving at definite conclusion regarding the surface roughness, further research involving greater sample sizes is necessary.

CONCLUSION

Ultraviolet irradiation sterilization of polyvinylsiloxane elastomeric impressions could be considered an effective

method compared to chemical disinfection since chemical disinfection results in a rougher impression surface. Among the two materials, Aquasil showed lower surface roughness compared to Elite HD⁺.

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