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A COMPARATIVE EVALUATION OF THE EFFECT OF CHEMICAL AND ULTRAVIOLET DISINFECTION ON DIMENSIONAL STABILITY OF POLYVINYL SILOXANE IMPRESSION MATERIAL: AN IN VITRO STUDY

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ABSTRACT

Introduction: In recent advances, ultraviolet (U.V) radiation has proved to be efficacious in killing the microorganisms. Little is known about the effect of this radiation on dimensional stability of addition silicone impression materials, hence a study was conducted to evaluate and compare the effect of U.V disinfection with chemical agents on dimensional stability of polyvinyl siloxane impression material. **Materials And Method:** A total of 60 samples of PVS impression material were fabricated and divided into 4 groups based on different disinfecting agents i.e. 2% glutaraldehyde, 0.5% sodium hypochlorite and U.V radiation. The impression samples were infected with S.mutans strains , incubated, after which the samples were disinfected, colonies were counted and compared with the control and different disinfectant groups. Following this, the dimensional changes in the samples were evaluated using travelling microscope. **Results :** Highly significant results were seen between the number of colonies obtained from control samples and the samples subjected to chemical and U.V disinfection. Whereas in terms of dimensional stability no statistically significant difference was observed between 2% glutaraldehyde, U.V chamber and 0.5 % sodium hypochlorite. **Conclusion:** All the disinfectants tested in this study they can be successfully used for disinfection purpose of Polyvinylsiloxane impression material as they were equally efficacious and did not cause any significant change on the dimensional stability of PVS impression material.

KEYWORDS :

INTRODUCTION

Impression materials can play a role in the transmission of infectious diseases between patients and dental staff. Dental professionals' health remains at risk due to the transmission of numerous pathogens, including cytomegalovirus, hepatitis B, hepatitis C, and human immunodeficiency virus[1,2] Therefore, impressions must be cleaned to reduce the chance of cross-infection among the patient, the staff assistant, and the employees of the dental laboratory. Since impression materials cannot be heat-sterilized, chemical disinfectants are the procedures of choice for disinfecting such materials.[3]

For the chemical disinfection of dental impression materials, a variety of substances are used, including glutaraldehyde, formaldehyde, alcohol, iodine solution, synthetic phenol, sodium hypochlorite, and other chlorine-releasing solutions.[4] Some studies suggest that 2% glutaraldehyde is the ideal solution for disinfection.[5,6] Glutaraldehyde when used in proper concentration, destroys all types of micro-organisms including bacteria, fungal spores, tubercle bacilli and viruses.[5]

Sodium hypochlorite (Naocl) is another very useful disinfectant having advantages which include fast bactericidal activity, relatively stable, low cost, non-staining and non-inflammable. One of the drawbacks of sodium hypochlorite is that it has a corrosive potential on the metal trays.[7,8] With advancements in technology newer methods to disinfect impressions have been introduced like the ultraviolet chamber and incorporation of antimicrobials and nano particles into the material itself. Ultraviolet rays have long been recognized as an effective method for eliminating microorganisms. While using dental UV chamber the wavelength used is 254 nm which is quite effective for disinfecting.[9,10,11]

The ideal disinfectant should serve the dual purposes of being an efficient antimicrobial agent as well as not negatively impacting the dimensional stability, surface characteristics, and final gypsum cast. Numerous studies[3,4,12–19] have evaluated the impact of chemical methods of disinfection on dimensional stability, but there is less information available regarding the use of UV rays for the same purpose. In order to compare and evaluate the impact of chemical and UV disinfection on infection control and dimensional stability of the polyvinyl siloxane impressions, an in vitro study was created. The current study's null hypothesis is that chemical and ultraviolet disinfection have no impact on polyvinylsiloxane's dimensional stability.

MATERIALS AND METHOD

In the present study, dimensional stability and infection control of polyvinyl siloxane impression material after chemical and UV disinfection were evaluated. The study comprised of 60 samples. A total of 4 groups having 15 samples each were employed according to the test material used i.e. polyvinyl siloxane impression material disinfected with 2% glutaraldehyde, 0.5% sodium hypochlorite, UV chamber and no disinfection (control group) respectively.

Stainless steel die according to ADA 19 was used to fabricate these samples. It consisted of three parts : (a) a ruled block (AA), (b) test material mold (BB) and (c) a riser (CC). The ruled block (AA) had three horizontal lines X, Y, Z and two vertical lines c d and c′ d′. The lines c d and c′ d′ were separated from each other by 25 mm. The test material mold (BB) was a cylinder of inner diameter 30 mm and depth of 6 mm to place the impression material. The riser (CC) was a stainless disk of diameter 29.9 mm and thickness of 3 mm. Test material mold (BB) was placed on the ruled block (AA) The polyvinyl siloxane impression material having medium body consistency was mixed in auto mixing device, dispensed into the mold and covered with a thin sheet of polyethylene followed by a rigid, flat, glass plate. After retrieval of samples, the distance between the lines cd and c′d′ before the disinfection was noted down as reading (A). The impression samples were infected with S.mutans strains, incubated, a solution of an inoculum strength of $5x10^5$ cell suspension volume was created for comparing the number of colonies that were present on the impression surface without disinfection and after disinfection with various disinfecting agents.

The samples were disinfected, colonies were counted again

using colony counter and compared with the control and different disinfectant groups (Figure 1). Following this, the dimensional change in the samples was evaluated with the help of travelling microscope. The findings were then compared with the dimensions that were recorded before disinfection procedure.

Percentage of dimensional change after disinfection was calculated as follows:
Dimensional change % = (A-B)/A × 100 Where A = the distance between the crosslines cd and c 'd ', reproduced in the impression before disinfection. B = the distance between the crosslines cd and c 'd ', reproduced in the impression after disinfection.

RESULTS

Values obtained were subjected to statistical analysis. Results were presented in Mean ±SD. Analysis of variance (ANOVA) was employed for inter group analysis of data and for multiple comparisons. Tukey's Post hoc test was applied All the analysis was carried out on statistical package for social science (SPSS) version 21 for windows (SPSSInc, Chicago, IL)
Comparative statistics of number of colonies on polyvinyl siloxane impression material after chemical and UV disinfection respectively using one way Anova F test revealed that highest colonies were observed in control samples (313.87) i.e. without disinfection whereas the least number of colonies were observed in Group 3 (6.0) with 0.5 % sodium hypochlorite disinfection and the difference was highly statistical significant ($p< 0.001$). In pairwise comparison (Table 1) while comparing with control group, there existed highly statistical significant difference with each group. No. of colonies in Group 2 (2% glutaraldehyde) > Group 3 (0.5 % sodium hypochlorite) & Group 4 (U.V Radiation) but the difference was not found to be of statistical significance ($p>0.05$). Number of colonies in Group 3 (0.5 % sodium hypochlorite) > Group 4 (U.V Radiation) but the difference was not found to be of statistical significance ($p>0.05$).

Comparative statistics of dimensional stability of polyvinyl siloxane impression material after chemical and UV disinfection respectively (Table 2) using One way Anova F test showed that no statistical significant difference ($p>0.05$) existed between four study groups. Group 2 had the highest dimensional change (0.1%) followed by Group 3 (0.06%), Group 4 (0.06%) and least change was seen in control (0.05%). However no statistical significant difference ($p>0.05$) was observed when pairwise comparison was done.

DISCUSSION

Oral cavity comprises of many surfaces, each coated with a plethora of bacteria. Some of these bacteria such as Streptococcus mutans (S. mutans), have been implicated in most common oral diseases such as caries and periodontitis. Most commonly used disinfectants for elastomeric impression material include glutaraldehyde and sodium hypochlorite. In recent advances, the use of U.V rays for disinfection of impression material has also become prevalent. UV light of 200-280 nm wavelength is lethal to bacteria, bacterial spores, viruses, mold, mold spores, yeast, and algae.

In the present study, U.V radiation of 254 nm wavelength at 11 W was chosen for disinfection procedure which is quite effective for disinfecting. This was in accordance with a study conducted by Aeran et al[9] in which it was found that complete and equal amount of disinfection was achieved with immersion in 2% glutaraldehyde and exposure to UV rays of 254 nm for 10 minutes each

In the present study after evaluating the number of colonies, it was seen that maximum number of colonies were found in the control group which was not subjected to any of the disinfection procedure, followed by 2% glutaraldehyde and U.V radiation. The least number of colonies were found after disinfection with 0.5% sodium hypochlorite solution. While evaluating the dimensional change, almost equal amount of variation was seen among all the groups.

On comparing the results for infection control, highest microbial count was seen in the control samples followed by disinfection with 2% glutaraldehyde, U.V chamber and 0.5% sodium hypochlorite respectively. In statistical analysis, using the one way Anova F test, highly significant results were seen between the control samples and the samples subjected to chemical and U.V disinfection. Results of Tukey's post hoc test showed that sodium hypochlorite caused the maximum destruction of colonies as compared to glutaraldehyde and U.V chamber but difference amongst them was not statistically significant. These findings were consistent with a related study by Bustos et al.[20], which found that immersion in 0.5% NaOCl and 2% glutaraldehyde for 5 and 10 minutes significantly inhibited bacterial growth on both irreversible hydrocolloid and silicone impressions when compared to the control group

While comparing the results for dimensional stability in the current study, statistically insignificant difference was observed among all the four groups. Chemical as well as U.V disinfection did not cause any alteration in the dimensional stability of the polyvinyl siloxane impression material. These results were in accordance with a similar study conducted by Amin et al.[15]In his study he found that 10 minutes of immersion in 0.5% sodium hypochlorite did not cause any dimensional variation and was better in comparison to 2% glutaraldehyde. Clinical implication of the present study is that use of chemical as well as ultraviolet radiation which is a recent modality for disinfection of dental impression can be readily used in daily dental practice to disinfect the Polyvinyl siloxane impression material as they do not have significant effect on dimensional stability of PVS impression.

There are certain limitations of the present study. Since it is an in vitro study, dynamic intra oral conditions like the effect of oral fluids including saliva and blood, soft tissue were not simulated in laboratory conditions. Furthermore, only one type of impression material that is polyvinyl siloxane was used. Other materials might show different results after treatment with different disinfecting agents that were used in this study. Nevertheless, further studies need to be conducted to evaluate the effect of chemical and U.V disinfection on various types of impression materials commonly used in daily dental practice.

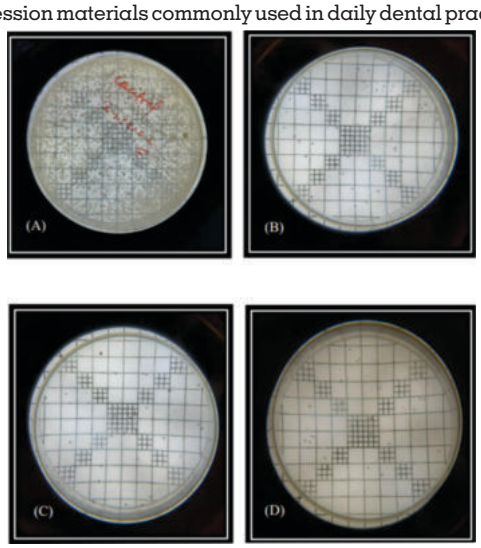

Figure 1: Colonies Of Streptococcus Mutans On Agar Plates A) Without Disinfection B) Disinfection With 2 % Glutaraldehyde C) Disinfection With 0.5% Sodium Hypochlorite D) U.v Radiation

Table 1 Pairwise Comparison Of Number Of Colonies On Polyvinyl Siloxane Impression Material After Chemical And Uv Disinfection Using Tukey's Post Hoc Test

Group	Comparison Group	Mean Difference	P value Significance
Group 1 (Control Group) vs	Group 2 (Glutaraldehyde)	299.13	p<0.001**
	Group 3 (Sodium Hypochlorite)	307.86	p<0.001**
	Group 4 (UV Group)	306.26	p<0.001**
Group 2 (Glutaraldehyde) vs	Group 3 (Sodium Hypochlorite)	8.73	p = 0.323
	Group 4 (UV Group)	7.13	p =0.502
Group 3 (Sodium Hypochlorite) vs	Group 4 (UV Group)	1.6	p =0.989

Table 2: Comparative Statistics Of Dimensional Stability Of Polyvinyl Siloxane Impression Material After Chemical And Uv Disinfection Respectively Using One-way Anova F Test

	Before Surface Treatment Mean (SD)	After Surface Treatment Mean (SD)	Dimensional change Mean (SD)
Group 1 (Control Group)	24.81 (0.33)	24.83 (0.24)	0.05 (0.05)
Group 2 (Glutaraldehyde)	24.64 (0.36)	24.66 (0.22)	0.1 (0.07)
Group 3 (Sodium Hypochlorite)	24.82 (0.34)	24.8 (0.24)	0.06 (0.04)
Group 4 (UV Group)	24.8 (0.26)	24.75 (0.24)	0.06 (0.05)
One way Anova F test	F = 0.953	F = 1.476	F = 1.933
P value, Significance	p = 0.421	p = 0.231	p = 0.135

CONCLUSION

Within the limitations of the study, following conclusions were drawn:

1. All the disinfecting agents tested in the study had the potential to successfully remove the bacterial load present and did not cause any statistically significant dimensional change in the polyvinyl siloxane impression material samples
2. Among the disinfecting agents 0.5% sodium hypochlorite showed the best efficacy, followed by U.V radiation and 2% glutaraldehyde against the streptococcus mutans strains but difference amongst them was not statistically significant.
3. All the disinfectants tested in this study can be successfully used for disinfection of polyvinylsiloxane impression material without causing any significant dimensional change.

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