Article type: Original article

Comparative assessment of dimensional changes after disinfection of elastomeric impression material with glutaraldehyde, ultraviolet light radiation, and ozone method

Running title: Dimensional changes after disinfection of impression materials

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Abstract

**Introduction:** Impression making is regularly performed in dental treatment, to make replica of the oral structures. This impression procedure is source of transmission and contamination of microorganism from patient to dentist and dental auxiliaries.

**Objective:** To evaluate the dimensional changes after disinfection of elastomeric impression material with chemical, ultraviolet light radiation, and ozone method.

**Materials and method:** Elastomeric impression was made using the aluminum mold with 3 parallel lines incorporated in impression to measure the changes in dimension. Changes in dimensional accuracy of elastomeric impression material after exposing the impression to respective disinfectant (Group A: Glutaraldehyde (2%), Group B: ultraviolet light radiation and Group C: ozone method, Group D: control) was evaluated. The obtained data was statistically evaluated.

**Results:** The difference in dimensional changes among the group was statistically significant when compared with control group. Lower dimensional changes were seen with ultraviolet irradiation followed by ozone method of disinfection.

**Conclusion:** It can be concluded that all the ultraviolet irradiation and ozone gas produces lesser dimensional changes compared to Glutaraldehyde.

**Key words**

Contamination, disinfection, impression, irradiation, ozone

**Introduction**

Health care professionals, especially dealing with oral diseases, are more vulnerable to cross infections during treating patients. The replica of oral structures is commonly performed by the dentists using impression in day-to-day practice. Through these impression procedure there is higher chances of transmission of infection and microorganisms from patient to dentist and laboratory technician. 1-3 Most commonly observed microorganisms in oral cavity of patients
wearing prosthetic dental appliances; removable orthodontic appliances consist of *Streptococcus*, *Lactobacillus*, *Staphylococcus*, *Actinomyces*, and *Candida* species. It was reported that dental personnel have a 5–10-fold higher chance of acquiring Hepatitis-B infection compared to general people.\(^1\) American Dental Association (ADA) and the Centers for Disease Control recommended disinfecting the impressions to prevent cross-infection.\(^4\)

Regular practice of infection control and safety measures is necessary to control cross-contamination and occupational exposures to blood and saliva-borne diseases. Transmission of microorganism through contamination from impression can be prevented by disinfection of impression material and dental casts and it can be labeled as disinfected. Foreign Direct Investment (FDI) (1998) guidelines suggested that all impression materials should be cleaned and disinfected before sending it to the laboratory (FDI Guidelines for Infection).\(^5\) Various methods of disinfection impression materials are suggested in literature and practiced such as; Microwave, gluteraldehyde, sodium hypochlorite, iodine, Autoclave, Ultraviolet radiation, and ozone methods.\(^1,2,6\) Recently antimicrobials and nanoparticles have been integrated into the impression material itself to make it self-disinfecting.\(^1\)

Chemical disinfection by means of immersion seems to be the most reliable and practical method, provided it does not adversely alters the dimensional accuracy of the impressions. Chemical means of disinfection can be done using Iodophors, Glutaraldehyde, Benzalkonium Chloride (0.25%), Ethyl Alcohol, Chlorhexidine and Sodium Hypochlorite. Glutaraldehyde is pungent colorless oil which can be used as disinfectant in liquid and gaseous forms. It possesses viricidal, bactericidal, sporicidal, fungicidal, and parasiticidal activity.\(^1\) Disinfection can be done by either spray or immersion method.\(^3\) Spray is considered as safest method of disinfection.\(^7\)

The efficiency of ultraviolet rays in disinfection based upon the intensity, time, humidity, and access to the microorganism. The maximum killing efficiency with UV light exposure has been obtained with 24 watts (3750 \(\mu\)W/cm²). Ozone is a gaseous inorganic molecule with the chemical formula of O3. Ozone water is considered as disinfectant since it is a potent oxidizing and antimicrobial, disinfectant, biocompatibility, and has healing properties.\(^1,4,6\)

The present study was done to evaluate the dimensional changes after disinfection of elastomeric impression material with chemical, ultraviolet light radiation, and ozone method.
Materials and Methods

This in vitro study was done in the department of Prosthodontics. In according to ADA specification 19, a solid cylinder of aluminum with 32 mm height was made which had three parts (ruled aluminum block, metal color, and riser). Three parallel lines (X, Y and Z) were imprinted 2.5 mm apart from each other with line running through the center indicating the diameter of the circular surface on inner surface of this cylinder. Two lines (cd and c, d) were imprinted perpendicular to the Y line such that cd and c, d were same distance from the center and 25 mm apart from each other. The insertion of line cd and line Y was indicated as Point A and that of c, d, and Y as Point B. When the metal collar was positioned over the test area of the aluminum block a mold cavity was observed measuring 30 mm in diameter and 2.5 mm in depth which would be the diameter of the test specimen.

Total 60 elastomeric impressions were divided into 4 groups with 15 samples for each group and they were disinfected with respective disinfectant (Group A: Glutaraldehyde (2%), Group B: ultraviolet light radiation and Group C: ozone gas method, Group D: control) and for control group no disinfectant was used. The changes in distance at point A and B after disinfectant were measured three times each and the average of the measurements was taken as a reference. These distances specify the linear dimensional changes. Obtained results were tabulated and statistically evaluated with SPSS software version 20.0 and using ANOVA test.

Results

The mean difference of dimensional stability was 26.063, 26.025, 26.035, and 26.014 for Glutaraldehyde, ultraviolet Irradiation, Ozone and for control, respectively (Table 1). The difference in dimensional changes among the group was statistically significant when compared with control group. Lower dimensional changes were seen with ultra violet Irradiation followed by ozone method of disinfection (Table 2).

Discussion

Impression of oral structure is routinely done by dentist. To achieve successful restorations an exact replicate of the teeth and the surrounding tissue must be clearly recorded and transferred to the model. Any dimensional change in the impression causes lack of
adaptation in the prosthesis. The main purpose of disinfection is to eliminate contaminated impression materials and dental casts from microorganisms. The immersion method is considered more effective because the immersion method guarantees that all surfaces of impression and tray are covered with the disinfectant solutions. During disinfection procedure, dimensional changes of the impression should be minimal. Hence the present study was done to evaluate the dimensional changes after disinfection of elastomeric impression material with chemical, ultraviolet light radiation, and ozone method.

Vatsal et al examined the dimensional accuracy of impression materials after disinfection with glutaraldehyde and microwave irradiation. They concluded that Microwave irradiation method was effective in reducing microbial count and can be used as an effective disinfectant method.

Amin et al assessed the effect of disinfecting impression materials on the dimensional accuracy and surface quality of the resulting casts using 0.2% chlorhexidine gluconate, 1% sodium hypochlorite, 2% gluteraldehyde for 5 min, and 0.5% NaOCl for 10 min. They concluded that the results were comparable with the standard specifications for dimensional stability and suggested that 10 minutes immersion in 0.5% sodium hypochlorite as the most appropriate disinfection protocol.

da Silva et al evaluated the dimensional stability of heavy and light bodied condensation silicones after immersion in disinfectant solution (1% sodium hypochlorite, 2% glutaraldehyde solutions) for 10 or 20 minutes. AlZain did a systematic review and meta-analysis to identify the different disinfection methods and materials. He stated that, some studies reported significant alteration in the properties of the impression materials; others reported either no changes or minor insignificant effects. Melilli et al assessed the dimensional stability of impression materials after disinfection with quaternary ammonium compound and glutaraldehyde plus amino derivative. They concluded that dimensional changes were clinically not relevant.

Azevedo et al assessed the antimicrobial effectiveness and the dimensional stability of addition silicone impressions after disinfection with 3% hydrogen peroxide, commercial disinfectant MD520 (Durr) and 1% and 5.25% sodium hypochlorite. They concluded that all
disinfectants tested showed high antimicrobial efficiency without significant changes in three-dimensional shape of impressions. 7

Karaman et al evaluated the efficacy of sodium hypochlorite and quaternary ammonium-based disinfectant solution on the surface roughness of an elastomeric impression material. They concluded that the extended application of the sodium hypochlorite disinfectant at 1% and 5% concentrations caused a considerable increase in the light body elastomeric impression material’s surface roughness. 8 Abinaya et al assessed the surface quality of silicone impression materials after ozone water, 2% glutaraldehyde, 5.25% sodium hypochlorite disinfection. They concluded that ozone water disinfection had least changes in comparison to 5.25% sodium hypochloride and 2% glutaraldehyde disinfection. 4 These results are comparable to our findings. We found lesser dimensional changes with ozone water compared to gluteraldehyde.

Al Shamy et al evaluated the effectiveness of autoclave and ozone disinfection protocols on the dimensional stability of polyvinyl siloxane (VPS) impression material. They concluded that VPS impression materials are dimensionally stable and produce accurate impressions with minimal distortion with the ability to retain these properties even after the disinfection procedures. 11 These findings are association with our results. Thota et al determine the effect of autoclaving on the dimensional stability of three different elastomeric impression materials. They concluded that statistically significant dimensional changes were observed for all the three impression materials (condensation silicone (GP1), addition silicone (GP2) and polyether (GP3)) at three different time intervals but this change was not clinically significant. 12

Carvalhal et al evaluate the influence of immersion period in two disinfectant solutions on dimensional change of four elastomeric impression materials. They stated that Combinations of molding material and disinfecting solution can be used in the dental clinic for infection control, without changing the dimensional. 13

Pisulkar et al assessed the efficacy of disinfection on elastomeric impression material using 2% Gluteraldehyde, UV Radiation Disinfection and Gaseous Ozone. They concluded that Dry gaseous ozone can be used effectively for disinfection of impressions without altering its dimensional stability. 14
A decontaminator for impression materials should accomplish two fundamental necessities; it must be an efficient antimicrobial agent and must protect the dimensional constancy and the surface details of both the impression and the resulting cast. ⁷

In the present study, control group had lowest dimensional changes, whereas the ultra violet irradiation and ozone produces lesser dimensional changes compared to Glutaraldehyde. All the disinfectants tested had clinically acceptable dimensional changes. We compared the chemical disinfectant with irradiation and ozone since use of chemical disinfects can be potentially harmful, time consuming, needs fresh preparation compared autoclaving, irradiation or other non chemical method. ⁵ The drawback of the present study was smaller sample size and we evaluated only 3 disinfectants. Further studies are needed to evaluate the dimensional changes of other impression materials after disinfectant application.

Conclusion

It can be concluded that all the ultra violet irradiation and ozone produces lesser dimensional changes compared to Glutaraldehyde.

Acknowledgement: Self

Conflict of interest: Nil

Source of Funding: Self
References


Legends for Illustrations

Tables

Table 1: Comparison of dimensional stability among test groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean difference</th>
<th>F value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: Gluteraldehyde</td>
<td>26.063</td>
<td>108.416</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Group B: ultraviolet light radiation</td>
<td>26.025</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group C: ozone gas</td>
<td>26.035</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group D: Control</td>
<td>26.014</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P-value derived from one-way ANOVA test; significant at p < 0.05

Table 3: Comparison of mean difference in dimensional changes

<table>
<thead>
<tr>
<th>Variables</th>
<th>Gluteraldehyde</th>
<th>Irradiation</th>
<th>Ozone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean dimension</td>
<td>26.063</td>
<td>26.025</td>
<td>26.035</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.0052</td>
<td>0.0021</td>
<td>0.0031</td>
</tr>
<tr>
<td>Mean difference form control</td>
<td>0.049</td>
<td>0.011</td>
<td>0.021</td>
</tr>
</tbody>
</table>