Original Article

Effect of four disinfectants on the dimensional accuracy of polyether, addition silicone and condensation silicone impression materials on the resultant gypsum casts - an in vitro study

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Abstract

Background:

Infection control has become an important concern for dental personnel in recent years. Dental impressions become contaminated with microorganisms from the patient's saliva and blood, which upon removal from the oral cavity can be a mode of potential disease transmission. Hence this study attempts to find a suitable disinfectant that will have the least adverse effects on dimensional accuracy of elastomeric impression materials.

Objectives:

To evaluate in-vitro the dimensional changes occurring in three elastomeric impression materials after immersing them with four commercially available disinfectant solutions.

Material and Methods :

Total of 180 impressions of acrylic master model were made using three different elastomeric impression materials and disinfected with the four different disinfectant solutions for 10 mins and casts poured in dental stone. The dimensional accuracy was recorded as a mean percentage deviation to provide an overall expression of accuracy. The mean of three linear measurements taken from the gypsum casts were compared to those recorded from the master model. This data was then converted to a mean percentage deviation using the formula,

(M — E/M) x 100

where M - master model measurement

E - experimental model measurement (control or post disinfection).

The dimensional accuracy was recorded as a mean percentage deviation to provide an overall expression of accuracy, a necessary requirement when constructing an oral prosthesis. Data was analyzed using analysis of variance (ANOVA) at the 50% confidence level.

Results and Conclusion:

In the light of the Present investigation, the, following. conclusions have been obtained

1. The four disinfectants employed in the present study affected all three impression materials very marginally except polyether which showed marked dimensional change which is above the ADA specifications for impression materials.
2. Addition silicone impression material is least affected dimensionally by the disinfection protocols followed in this study.
3. Of all the disinfectants employed in the present investigation; l% sodium hypochlorite showed the least changes in the dimensions of the three impression materials.

Key Words: Addition Silicone condensation silicone , elastomeric impressions, HIV, Microorganisms, polyether.

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Introduction

Contamination of the working atmosphere by several microorganisms from the oral flora during the clinical practice of dentistry offers constant risks to the health professionals. Strong evidences have been shown in the literature regarding the pathogenesis and intensity of the viruses of hepatitis B (HBV), herpes, tuberculosis and acquired immunodeficiency syndrome (AIDS) in dentistry.[1]

Dental impressions consist of a dimensionally stable material which is capable of recording the desired anatomic area. The impression then displays the anatomy of the impressed area. During this procedure, the material has contact with saliva and blood, which are sources of contamination, and carries a great number of microorganisms of the oral flora upon removal from the mouth. Some of the several types of impression materials currently employed in dentistry have a great potential to retain microorganisms on their surfaces. Poulos and Antonoff (1997) stated that the polyvinyl siloxane is the most resistant to the retention of microorganisms, followed by the polysulphide. Besides, the number of microorganisms in these materials is quickly reduced through disinfection procedures[5].

The top concern of dental professionals is mainly related to the dimensional alteration of the impressions in procedures involving high dimensional precision. Rivers et al (1996) stated that many dentists avoid to accomplish disinfection by immersion, giving preference to the aerosols, fearing distortion of the impression[1]. The efficiency of disinfection methods and their consequences on the impression materials are being investigated since 1974[9]. Leung and Schonfeld (1983) observed the transfer of microorganisms from the impressions to the plaster casts, bringing about a risk of contamination to the laboratories of dental prosthesis. Therefore, the disinfection of impressions is a fundamental procedure in the routine dental practice[2,4].

Occupational safety and health association (OSHA) guidelines in 1996 required dentists, dental laboratory employers, and other employers in health care fields to provide protection for their employees against the possibility of infection transmission by implementation of conscientious and consistent barrier controls[2].

Impressions are a potential vehicle in transmission of infectious agents. Moreover, casts produced from contaminated impressions may themselves be contaminated because microorganisms are able to migrate from the impressions into the casts, while setting occurs. The disinfection of impressions, and other laboratory fabricated material, is more difficult and requires immersion. The agent chosen must not have a deleterious effect on the dimensional stability of impression materials, and must act in a reasonable time.

Hypochlorites, aldehydes, alcohols and chlorehexidine, which are used as disinfectant solutions is this study are the most widely used disinfectants. They have a broad spectrum of anti-microbial activity and are both inexpensive and fast acting.

The purpose of this study is to evaluate the effect of four commercially available disinfectant solutions on the dimensional stability of Addition silicones, Condensation silicones and Polyether impression materials on their resultant gypsum casts; so as to assist in the selection of the most suitable disinfectant solution for a particular elastomeric impression material to be used in patients.

Aims And Objectives

This study had following Aims and Objectives

1. To evaluate the effect of four disinfectants on the dimensional accuracy of Polyether, Addition silicone and Condensation Silicone impression materials on the resultant gypsum casts.

2. To assist in the selection of the most suitable disinfectant solution for a particular elastomeric impression material to be used for the patient

Materials And Method

Fabrication of Acrylic master model

An acrylic master model was made to replicate an edentulous maxillary arch using self cure acrylic resin (DPI, India).

On the master model five points (Fig.1) were indented in the approximate position of the incisive papilla(A), left(C) and right second molar(B) and in the centre of hard palate(D).

Fabrication of metal studs

The metal studs were fabricated using laser

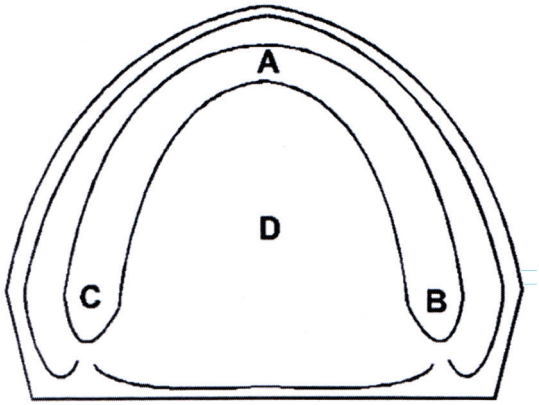

Figure 1: Master model used in study

sintering and perfect "x" shaped groves were carved on the occlusal surfaces using metal cutting laser (Fig.5) for reproduction of accuracy.

Fabrication of custom trays

The model was then duplicated and cast poured in stone to act as a master template for the construction of the trays. Custom made self cured acrylic special trays (Fig.6) were made by uniformly covering the model with 4mm of spacer wax with 'stops' cut out in the approximate positions of the palatine fovea and left and right premolar positions. Custom trays were then fabricated on duplicated model and respective tray adhesives applied on the custom trays and trays were dried.

Preparation of samples

Impressions were taken of the master model using three different elastomeric impression materials (Fig.2) viz, condensation silicone (putty) (ZETA PLUS,ZHERMACK,ITLAY), polyether (medium body) (IMPREGUM, 3M ESPE,USA) and addition silicone (putty) (EXPRESS XT, 3M ESPE,USA) and

Figure 2: Impression Materials used in the study

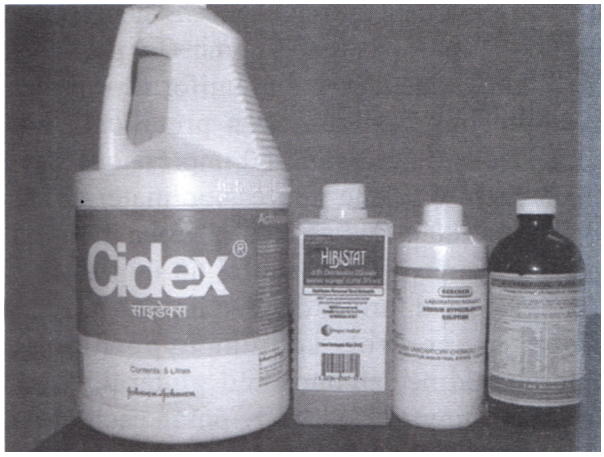

Figure 3: Disinfectants used in the study

Figure 4: Dental stone used in the study

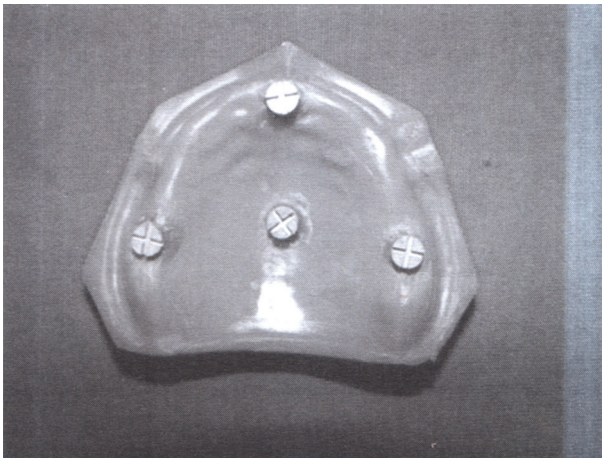

Figure 5: Metal studs in place on acrylic model

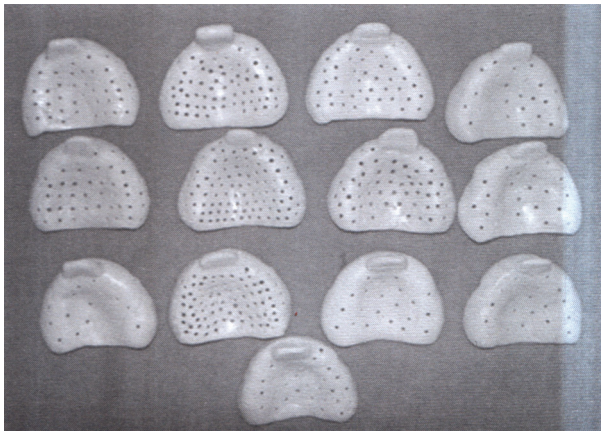

Figure 6: Custom trays used in the study

allowed to set for 8 mins for condensation silicone and poly vinyl siloxane and 12 mins for polyether. Light body was mixed and uniformly applied over the impressions taken previously and impressions made again. 60 impressions were made each with one impression material and totaling to 180 including control group. For each group of impression material 60 impressions were made and further divided into 12 in every group as, control, sodium hypochlorite, chlorehexidine, alcohol and glutaraldehyde (Fig.3). 12 impressions were put in each of the boxes containing disinfectant solutions and stop watch set to ten mins. After 10 mins were over, impressions were taken out and rinsed under running water and air dried. The procedure was repeated until all impressions were disinfected of the concerned group. To the control group no treatment was done. Type III dental stone(Kalabhai,India) (Fig.4) was used to pour the casts. Casts (Fig.8) were allowed to set for 45 mins and removed from impressions and checked for faults. Later casts were trimmed and finished and made ready for measurements.

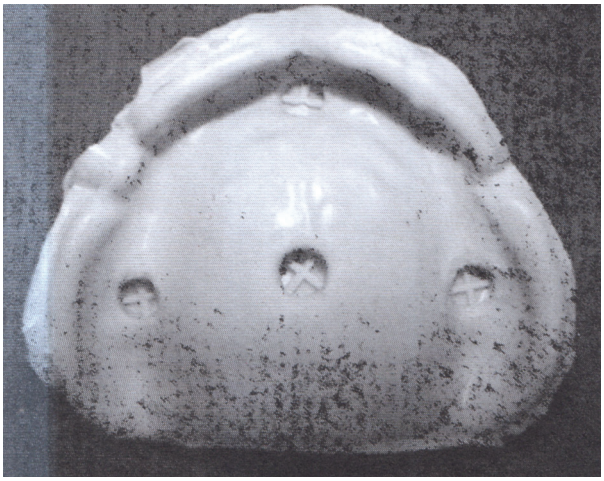

Figure 7: Light body impression

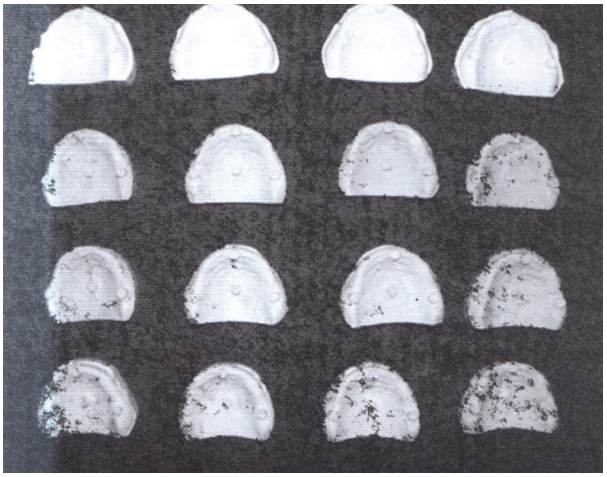

Figure 8: Casts obtained from elastomeric Impressions

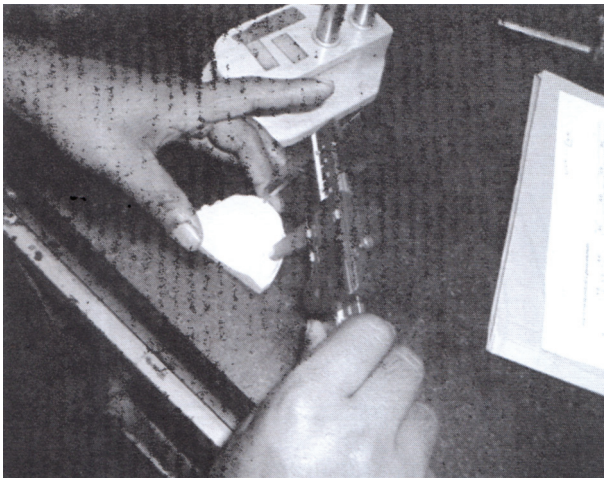

Figure 9 : Casts measured by Digital Caliper

Results

This study evaluated the dimensional change in three elastomeric impression materials after disinfection with four disinfectant solutions, on their resultant gypsum casts. The overall dimensional accuracy of each specimen cast was expressed as a mean percentage deviation of six linear measurements. They were then added to get overall Mean percentage deviation and compared to master model. The results of the study are expressed graphically from Graph 10 To 14. This data was then converted to a mean percentage deviation using the formula,

(M -E/M) x 100

where M - master model measurement

E - experimental model measurement

(control or post disinfection).

The dimensional accuracy was recorded as a mean percentage deviation to provide an overall expression of accuracy.

Table 1 : shows the distance in mmbetween the points A-B, A-C, A-D, B-C, B- D and C-D on the acrylic master model.

Table 1 : ***Mean values of measurements of master model in MM***

MASTER MODEL	A-B	A-D	A-C	B-D	C-D	B-C
1	36.27	24.07	35.80	22.79	24.21	48.20
2	36.26	24.07	35.81	22.78	24.20	48.19
3	36.27	24.07	35.81	22.78	24.20	48.20
4	36.27	24.06	35.80	22.78	24.20	48.20
5	36.27	24.07	35.79	22.78	24.20	48.20
6	36.26	24.08	35.79	22.79	24.20	48.20
7	36.27	24.06	35.80	22.78	24.21	48.19
8	36.27	24.07	35.80	22.78	24.22	48.19
9	36.26	24.06	35.80	22.79	24.22	48.19
10	36.28	24.07	35.80	22.79	24.22	48.20
11	36.27	24.05	35.81	22.78	24.22	48.20
12	36.27	24.06	35.81	22.79	24.22	48.20

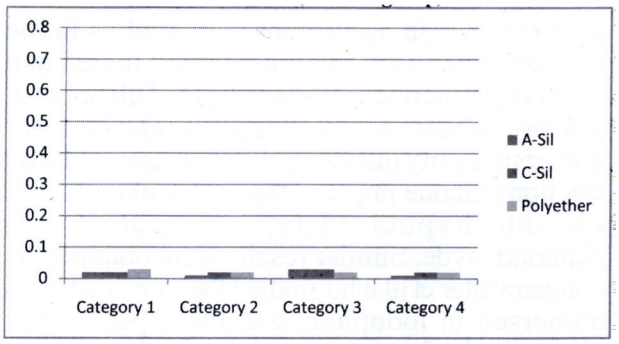

Figure 10: Mean percentage deviation from the master model without disinfection (control group).

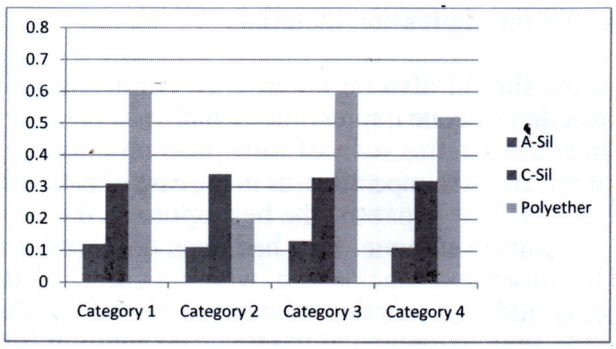

Figure 11: Mean percentage deviation from the master model after disinfection with Glutaraldehyde in all the three impression materials.

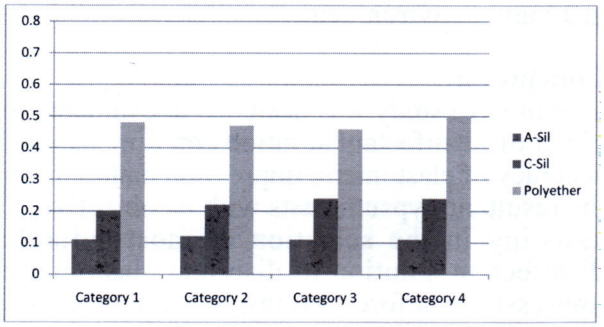

Figure 12: Mean percentage deviation from the master model after disinfection with Sodium Hypochlorite in all the three impression materials.

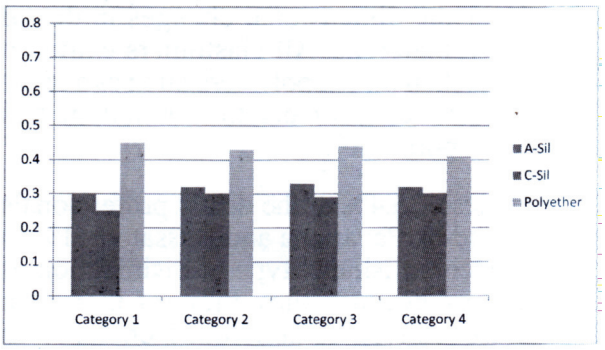

Figure 13: Mean percentage deviation from the master model after disinfection with Chlorehexidine in all the three impression materials.

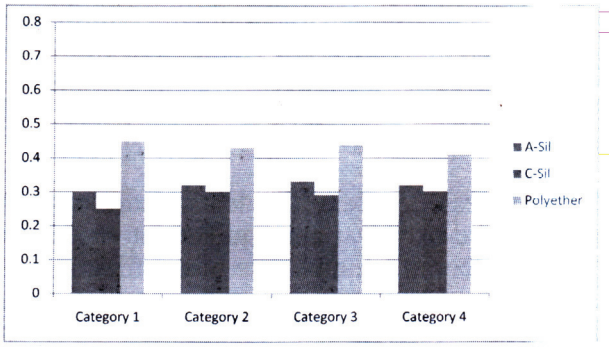

Figure 14: Mean percentage deviation from the master model after disinfection with Ethanol in all the three impression materials.

The results were statistically analyzed using One-way ANOVA as there were more than two groups for comparison and analysis. When One-way ANOVA was applied to means of distances for the groups, the results were obtained revealed a significant differences between and within the groups for Polyether impression material disinfected with all the four disinfectant solutions whereas for Addition silicone and Condensation silicone it was not significant. (p= 0.1224) t —test was done to assess whether the means of two groups are statistically different from the each other by hypothesizing that the difference between the two observations is zero. If p — value associated with t- test is low (-'3d0.05), there is evidence to reject the null hypothesis. Thus, we would have evidence that there is a difference in means across the paired observations.

Discussion

The risk of cross infection in dentistry is a topic of interest. In order to protect all the members of the dental team, a high standard of hygiene and disinfection of dental equipment, including dental impressions is recommended. This study evaluated and compared the dimensional changes of three elastomeric impression materials as a result of impression disinfection by immersion. Impressions were subjected to 4 different disinfectants for a period of 10 mins and poured to make dental stone casts. For comparative purposes, dimensional changes were also assessed when the impression did not undergo any disinfection (control group). Considering the material itself, addition silicones are expected to result in higher dimensional stability than condensation silicones. The discrepancies detected for these materials may result, among the other reasons, from the incomplete elastic, recovery or from the residual polymerization, resulting in shrinkage of the impression. Durr et al stated that there are many

origins for the dimensional changes in dental impression materials. All elastomers exhibit a light contraction during polymerization as a result of the volume reduction due to cross linking and alcohol evaporation[10].

Nevertheless, 35.4% of the dental professionals interviewed by Pavariana and Bussatore (1996) did not accomplish any type of disinfection of impressions because they thought that such procedure causes dimensional changes in materials. Considering this evidence, other alternatives have been proposed for the disinfection of impressions[2].

The method employed in this investigation took into account the recommendation of several authors that 10 min of immersion into disinfectant solutions is enough to eliminate the viable bacteria from the surface of the impression.[10, 12 13 14 17]

According to Durr et al even though procedures to test the effectiveness of the disinfectant solutions against AIDS and Hepatitis B virus have not been developed yet, it is apparent that immersion for 10 minutes in high level germicide such as sodium hypochlorite or glutaraldehyde will allow to achievement of a material with virus free surface[10].

The silicones and polyether tested presented high dimensional stability during the 10 minperiod, confirming the study of Thouti A et al. [7, 17] The results of present study show that addition silicone expanded minimally in immersion disinfection and greatest expansion was in sodium hypochlorite ie 0.12% but that change was insignificant when compared to ADA specifications. Condensation silicone impression material also showed good dimensional stability and lead to a total expansion of 0.2- 0.4%. Slight contraction — (0.12% - 0.30%) was observed in condensation silicone, that can be explained on the basis of loss of byproducts of polymerization, otherwise dimensional changes were within the range specified by ADA.

Polyether impression material showed significant expansion from the control but greatest was 0.68% with glutaraldehyde. Percentage expansion in polyether impression material ranges from 0.4%-0.68%, and that is above ADA specifications.

When the mean values for the stone casts were compared on the basis of the disinfectant treatment factor, the results of analysis of variance were confirmed, which proved to be non significant. These data indicate that the disinfecting treatment did not cause any significant change in the elastomers compared with the control group.

This result is in agreement with studies in the literature that used the most varied media and times of immersion. For example, Tullner et al did not observe any negative effect after immersing polysulfide, polyether, and addition reaction silicone impressions in iodophor, 5.25% sodium hypochlorite, or neutral 2% glutaraldehyde. Similar results were obtained by Langenwalter et al who studied the same materials immersed in iodophor, sodium hypochlorite, glutaraldehyde or twice deionized water, or exposed to room air for 10 minutes[30]. Similarly, Mathyas et al concluded that there was no adverse effect of the various disinfecting media on the different impression materials[13].

Care should also be taken with condensation reaction silicone impressions, which may contract because of the loss of sub products. When sterilization is imperative, as in the case of patients with HIV or hepatitis, the best option is the use of addition silicone. This had been observed by Johansen and Stackhouse, who concluded that only addition reaction silicone remained stable after immersion in a glutaraldehyde solution for 16 hours, whereas polysulfide and condensation reaction silicone contracted both in a dry environment and in immersions, and polyether contracted in a dry environment and expanded in a humid environment.

Conclusion

This in vitro study was designed to evaluate the effect of disinfectant solutions on dimensional accuracy of elastomeric impression materials on the resultant gypsum casts with an objective of assisting in the selection of most suitable disinfectant solution to disinfect elastomeric impressions before sending to the laboratory.

Therefore in the light of the present investigation, the following conclusions have been obtained

1. The four disinfectants employed in the present study affected all three impression materials very marginally except polyether which showed marked dimensional change which is above the ADA specifications for impression materials.
2. Decontaminated addition-silicone impressions using all the employed disinfectants produced stone casts with dimensions very closely comparable to

those of standard acrylic model. This shows that the addition silicone impression material is least affected dimensionally by the disinfection protocols followed in this study.

3. Of all the disinfectants employed in the present investigation, 1% sodium hypochlorite showed the least changes in the dimensions of the three impression materials.

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