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A Comparative Evaluation of Dimensional Change of Addition Reaction Elastomeric Impression Material after Disinfecting with 1% NaOCL and 3% H_2O_2: An in Vitro Study

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Abstract

Elastomeric impression materials are most commonly used impression materials in clinical practice for treating partially edentulous patient. After making impression it needs to be sterilized properly to minimize the risk of cross infection. Dimensional stability and accuracy of an impression after chemical disinfection by using different disinfectants are crucial for the accuracy of final prosthetic restoration. Until 1991 the recommended procedure for disinfection of impression was rinsing under running water with which only 40% of bacteria, virus, and fungi were removed and potential for transmission of microorganism remained there. Now a days most clinically used disinfection solutions are 3% hydrogen peroxide and 1% sodium hypochlorite. These two solutions are more effective to diminish microorganisms from the impression surface without altering dimensional stability.

Objective: To evaluate and compare the dimensional change of addition reaction elastomeric impression material after disinfecting with 1% NaOCL and 3% H_2O_2.

Methods: It iwas a quasi experimental type of in vitro study. This study was done in the Department of Prosthodontics in BSMMU, during the period of October 2021 to October 2022.Specimens of addition reaction impression materials were prepared from a plexiglass mold used as a specimen of this study. Plexiglass mold was fabricated with the measurement of 100 mm length,10 mm width and 3 mm thickness This mold had some indentations like two parallel horizontal lines and two vertical lines that cross its surface at each end. Totally 32 specimen for each disinfectant solution were included in this study, among them 16 specimen were prepared with addition reaction impression material after disinfecting with 1% NaOCL in a thickness of 3 mm. Another 16 samples were prepared with addition reaction impression material after disinfecting with 3% H_2O_2 in a thickness of 3 mm. Samples of addition reaction impression material of putty consistency was prepared by taking half spoon base and half spoon of catalyst and kneaded by fingers till uniform color appears and then loaded into the plexiglass mold. The cover of the mold was applied with finger pressure and secured to the base. Excess

material was flowed out of the mold through two holes of the lid. the sample was removed form the mold after setting time of 6 minutes. All sample were prepared and their length, width and thickness was measured by electronic vernier caliper at two points. The measurement was averaged and used as the thickness of samples. Afterwards, the samples were visualized with a magnifying loupe (Wild / Leica M420) where, under a magnification of 4.5x. Measurements were made 2 times for each of the 32 samples.

Keywords: Chemical disinfectant, Dimensional stability, Sterilization

1. Introduction

The fabrication of a good prosthesis begins with making of a good impression. Fabricating a precisely fitting prosthesis fully depends on an accurate impression making. From time to time, impression materials have evolved due to their better physical and handling properties. It is significantly important to create awareness to dental professionals about the handling, transportation, processing and storage of dental impressions (Sridharan et al., 2019).

During impression procedure, impression materials often come in contact with saliva and blood, which may get infected with infectious diseases such as AIDS, herpes, hepatitis or tuberculosis. Hence, disinfection of impression material is important as dentis, dental laboratory person often expose to infectious disease. In 1998, FDI guidelines suggested that all impression material should be disinfected before sending to laboratory (Guiraldo et al., 2012).

The majority of private clinics, hospitals, dental schools and even prosthetic laboratories are not following the required guidelines for disinfecting the impression which leads to cross infection. With this background the aim of the review is to concentrate on the various techniques of impression disinfection along with their mechanism of action, dimensional stability, cause of infection on impression material and effect of disinfectant on impression materials. (Jayalakshmi et al., 2015)

The need for more stable and accurate elastic impression material triggered the introduction and development of elastomers in dentistry in the 1960s in Germany. Elastomers are synthetic rubber based materials previously known as rubber impression materials but now more commonly referred to as non-aqueous elastomeric impression materials. Polyvinyl siloxanes are currently considered to reproduce the greatest detail of all the impression materials. The accuracy of impression material is dependent on its dimensional stability. PVSs show the smallest dimensional changes on the setting of all the elastomeric impression materials.

The majority of this shrinkage is due to continued polymerization occurring within the first 3 min of removal of the impression from the mouth. Reductions in volume as low as 0.1 to 0.05% due to polymerization have been reported (Surendra et al., 2011). Use of disinfectant in dentistry is important for eliminating cross contamination. Disinfection procedure should be proper because it is important for dimensional stability of impression materials. (Soganci et al., 2018).

Dental impression after taking out the patient mouth, the material contained saliva and blood, which is the source of infection. Even the presence of caries have microorganisms in them which is seen in the impression material after removal (Sherlin et al., 2015).

A study carried out in Hong Kong that only 48% of the dentists disinfected their impressions and only 74 % rinsed their working impression after removal from the mouth. A similar recent study in Ireland revealed that 18% of the dentists do not disinfect their impression (Rath et al., 2010).

One of the primary functions of dental surgeons as health professionals is to prevent diseases in their field or when diseases are set in to treat it. The actual worrying about the cross infection strongly increased after the rapid evolution of AIDS and hepatitis B, leading the American dental Association (ADA) to publish guidelines about the control of infection in dental offices and laboratories (Badrian et al., 2012).

Manufacturer's instructions recommend disinfecting impression materials by using chemical solutions. Several methods of disinfection are used to disinfect the different impression materials. Among these, the most frequently used method is the chemical method where a chemical disinfectant is applied to the surface of the impression materials either by spraying or immersion.

Disinfectants with different concentrations may be used such as 1% sodium hypochlorite and 3% hydrogen peroxide between these, NaOCl disinfectants are widely used. After contamination, all samples were rinsed with sterile distilled water for 30 seconds. In the present survey 0.525% hypochlorite sodium agent which is common in housework was used.

This disinfectant agent could efficiently prevent microorganisms growth and disinfect the impression materials. Despite studies in literature there is a need for consensus development to the ideal composition and concentration of chemical disinfectant, optimal exposure time, and the interaction between impression material and disinfectant solutions (Goel et al., 2014).

In Westerholm study, it was that Sodium hypochlorite can absolutely (99.99%) prevent the growth of Staphylococcus aureus and these results are in agreement with the results of the present study as this material eradicated 97.12% and 98.84% of Staphylococcus aureus after 5 and 10 minutes, respectively. In another study by Ghahramanloo and colleagues, spraying sodium hypochlorite 0.525% could disinfect samples effectively (96.6%) in 10 qminutes (Ghahramanloo et al., 2009).

Two main concerns for disinfectant evaluation are: efficiency of disinfecting solutions in eliminating pathogens, and the influence of disinfection treatment on the dimensional stability of dental impression materials. It been thought that disinfectants can alter the dimensional accuracy of impression materials. Studies showed no statistical differences regarding dimensional stability, when spraying was compared to immersion as a disinfection method (Gounder et al., 2016).

A study by Marques et al. (2014) performed in Viseu (Portugal), shows that only 60.3% of dentists report disinfecting the impressions and that the majority (51.6%) of the inquired dentists disinfect the

impressions by spray. Hence, the purpose of this study was to evaluate and compare the dimensional accuracy of elastomeric impression material when treated with chemical disinfectants (Ramakrishnaiah et al., 2012).

Abbreviations and Acronyms

Dental prosthesis: An artificial replacement of one or more teeth and/or associated structures.

Fixed prosthodontic: The branch of prosthodontics concerned with the replacement and/or restoration of teeth by artificial substitutes that cannot be removed from the mouth by the patient.

Impression: A negative likeness or copy in reverse of the surface or object. (GPT)

Impression Material: Impression materials are used to copy the teeth and surrounding oral structures by creating a dental impression poured with dental plaster to fabricate a dental cast. This procedure provides a tridimensional and accurate mouth replica, allowing dental work even in the absence of the patient.

Disinfectant: A disinfectant is a chemical substance or compound used to inactivate or destroy microorganisms on inert surfaces.

Plexiglass Mold: This is an acrylic glass custom mold which can be a simple box is the most effective way to contain the silicone.

Electronic Vernier Caliper: The Digital Caliper (sometimes incorrectly called the Digital Vernier Caliper) is a precision instrument that can be used to measure internal and external distances extremely accurately.

Magnifying Loupe: A loupe is a simple, small magnification device used to see small details more closely. They generally have higher magnification than a magnifying glass, and are designed to be held or worn close to the eye.

3. Materials and Methods

Type of study

Cross sectional comparative type of study.

Place of study

This study was carried out in the Department of Prosthodontics, Faculty of Dentistry, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh.

Study time period

May 2020 to October 2022.

Study sample

Addition Reaction Elastomeric Impression prepared from prefabricated plexiglass mold.

Sampling Technique

Purposive sampling technique was used to select the sample for this study. All the available sample were picked up that meet the preset inclusion criteria set for this study till the desired sample size is reached

Sample size

A total of 32 specimen were included in this study.

Sample size estimation

$n=((Za+Z\beta)^2 X (\sigma_1^2+\sigma_2^2))/(\mu 1-\mu 2)^2$

$z\alpha$= z- value of standard normal distribution at 95% power=1.96
$z\beta$=z-value of standard normal distribution at 5% level=0 .85
$\mu 1$=98
$\mu 2$= 95
$\sigma 1$= 3
$\sigma 2$= 3

n= $((1.96+0.811)^2 x\{(3)^2+(3)^2)\})/((98-95)^2)$
= 7.67 ×18/9
= 138.06/9
=15.34 ≈16 [for each group]

Sample size was 16 in number in each group
So, the total sample size was 16×2=32.
[Mean values and standard deviations were taken from study of Gothwal et al. (2019)]

Criteria for sample selection

Inclusion criteria

The impression without any defect during removal from the study mold was included in the study.

Exclusion criteria

Defective Addition reaction silicone impression material
Impression with voids were excluded
Impression with non-uniform color
Impression with rough surfaces
Impression with fins
Torn impression material

Study procedure

Equipment and Materials used for this study

Neopure, Addition Reaction silicone impression material , Oricam Health Care

Rectangular Plexiglass Mold

Electronic Vernier Caliper

Magnifying Loupe

Disinfectant (1% NaOCl and 3% H_2O_2)

Preparation of the mold

This Cross sectional type of l study, had been carried out in the laboratory at department of Prosthodontics at BSMMU. Only the specimen of addition reaction elastomeric impression material removed from the plexiglass mold without any defect was included in this study. Plexiglas is a plastic material made from polymers of methyl methacrylate, the plexiglass mold was fabricated with the measurement of 100 mm length, 10 mm width and 3 mm thickness. This mold had some indentations like two parallel horizontal line and two vertical line that cross it's surface at each end.This mold had a lid and a secured base, there was two holes over the lid so that excess material flowed out of the mold through the holes. There was an extra half shaped mold through which exact measurement of the specimen was done by shaping it with the help of scalpel.

Preparation of the specimen The specimen was made of addition reaction elastomeric impression material prepared from the plexiglass mold. Specimen of addition reaction elastomeric impression material of putty consistency had been prepared by taking half spoon base and half spoon of catalyst and kneaded by finger till uniform colour appears and then loaded into the plexiglass mold. The cover of the mold applied with finger pressure over the specimen and secured to the base. Excess material flowed out of the mold through the two holes of the lid. The specimen had removed from the mold after setting time of six minutes. All specimen was being prepared and length, width and thickness measured by electronic Vernier calipers at two points. Afterwards Examination of the specimen and recording of the dimensional changes according to the criteria to be mentioned performed by the investigators. For ease of recording and to make comparison, possible length, width and thickness of the specimen to each preparation after using 1% NaOCl and 3% H_2O_2 disinfectant was being recorded separately. The specimen had been examined under an adjustable light using 4.5x magnifying loupe. Dimensional changes of the specimen measured with the help of the electronic Vernier caliper. Total 32 for each disinfectant solution was included in this study and first of all specimen was disinfected with 1% NaOCl and then remaining specimen was disinfected with 3% H_2O_2.

Addition reaction silicone impression material

1% sodium hypochlorite disinfectant solution

3% hydrogen peroxide disinfectant solution

Electronic Vernier caliper

Magnifying loupe

Specimen

Plexiglass mold

Shaping of specimen with the help of scalpel

Specimen after disinfection

Data collection

Data were collected and recorded in a predesigned data collection sheet enclosed here with on the basis of specific parameter of the study.

Data processing and presentation

The Collected data were processed by editing, checking, rechecking. The edited data were classified and presented in different table, graph and figure in result section.

Statistical Analysis

Results were summarized and analyzed by using appropriate statistical data analysis method. Data were expressed as mean and standard deviation. Appropriate test was performed as applicable. P value <0.05 was considered as statistically significant.

Ethical considerations

Ethical clearance for the study was taken from the institutional review board (IRB) of BSMMU prior to the commencement of the study. Before the research protocol was approved by the board, permission for the study was taken from the department of prosthodontics, BSMMU.

2. Results

The present study aimed to evaluate the dimensional change of addition reaction elastomeric impression material after disinfecting with 1% NaOCl and 3% H_2O_2.A total of 32 specimen of addition reaction elastomeric impression material were included in this study. The results of the study data were measured in terms of mean values. Unpaired t-test were performed. The findings obtained from the study are presented as results in different tables and figures on the following pages.

Table-I: Comparison of mean length of addition reaction elastomeric impression material specimen after disinfecting with 1% NaOCl and 3% H2O2 solution (N=64)

Variable	1% NaOCl disinfectant solution (n=32) Mean±SD	3% H_2O_2 disinfectant solution (n=32) Mean±SD	t-value	*p*-value
Length of the specimen (mm)	0.117±0.185	0.181±0.245	-1.173	0.245[ns]

Data are expressed as mean ± SD. Unpaired t-test was performed for comparison between two groups.
The test of significance was calculated & p value <0.05 was accepted as level of significance.
N= number of total study subjects
n= number of subjects in each group
ns = not significant

In Table-I shows that no significant difference was found in mean length of specimen in 1% NaOCl and 3% H_2O_2 (p=0.245) disinfectant solution. However, more changes were observed in 3% H_2O_2 (0.181±0.245) compare to 1% NaOCl (0.117±0.185).

Table-II: Comparison of mean width of addition reaction elastomeric Impression material specimen after disinfecting with 1% NaOCl and 3% H_2O_2 solution (N=64)

Variable	1% NaOCl disinfectant solution (n=32) Mean±SD	3% H_2O_2 disinfectant solution (n=32) Mean±SD	t-value	*p*-value
Width of the specimen (mm)	0.185±0.241	0.256±0.255	-1.142	0.258[ns]

Data are expressed as mean ± SD. Unpaired t-test was performed for comparison between two groups.
The test of significance was calculated & p value <0.05 was accepted as level of significance.
N= number of total study subjects
n= number of subjects in each group
ns = not significant

In Table-II shows that no significant difference was found in mean width of specimen in 1% NaOCl and 3% H_2O_2 (p=0.258) disinfectant solution. However, more changes were observed in 3% H_2O_2 (0.256±0.255) compare to 1% NaOCl 0.185±0.241).

Table-III: Comparison of mean thickness of addition reaction silicone impression material specimen after disinfecting with 1% NaOCl and 3% H_20_2 solution (N=64)

Variable	1% NaOCl disinfectant solution (n=32) Mean±SD	3% H_2O_2 disinfectant solution (n=32) Mean±SD	t-value	*p*-value
Thickness of the specimen (mm)	0.178±0.196	0.158±0.158	0.408	0.685^{ns}

Data are expressed as mean ± SD. Unpaired t-test was performed for comparison between two groups. The test of significance was calculated & p value <0.05 was accepted as level of significance.
N= number of total study subjects
n= number of subjects in each group
ns = not significant

In Table-III shows that no significant difference was found in mean thickness of specimen in 1% NaOCl and 3% H_2O_2 (p=0.685) disinfectant solution. However, more changes were observed in 1% NaOCl compare to 3% H_2O_2 (0.178±0.196 vs 0.158±0.158).

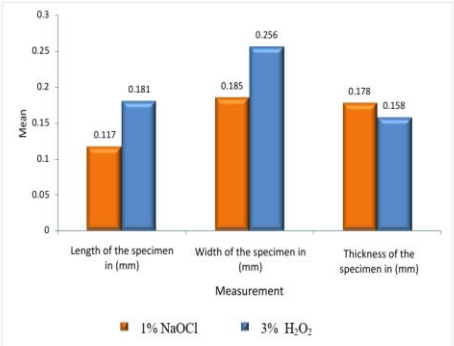

Figure-1: Bar diagram showing the length, width and thickness of addition reaction silicon impression material specimen after disinfecting with 1% NaOCl and 3% H_20_2 solution (N=64)

In Figure-I shows that no significant difference in mean length, width and thickness of specimen in 1% NaOCl and 3% H_2O_2 (p>0.05) disinfectant solution. However, more changes of length were observed in 3% H_2O_2 (0.181±0.245) compare to 1% NaOCl (0.117±0.185); more changes of width were observed in 3% H_2O_2 (0.256±0.255) compare to 1% NaOCl (0.185±0.241). Regarding thickness more changes were observed in 1% NaOCl (0.178±0.196) compare to 3% H_2O_2 (0.158±0.158).

Discussion

The successful outcome of a dental prosthesis depends on proper impression making. After making a proper impression it must be needed to disinfect for eliminating cross infection. Maintenance of dimensional stability is also important after using disinfectant which will help to provide a perfect cast as well as longevity of the prosthesis. The purpose of this study was to evaluate and compare dimensional change of addition reaction elastomeric impression material after disinfection with 1% NaOCL and 3% H_2O_2. In this study total 32 specimen were selected and compared their length, width and thickness after disinfecting with 1% NaOCL and 3% H_2O_2.

On this present study table-I shows that the mean value of changed length of addition reaction elastomeric impression material after disinfecting with 1% NaOCl and 3% H_2O_2 were 0.117 mm and 0.181 mm respectively.

This present study uses only one impression material that is addition reaction elastomeric impression material and two disinfectant is mixed according to the manufacturer instructions and then specimens were prepared. Current study found least dimensional change in the length of addition reaction elastomeric impression material specimen after disinfecting with 3% H_2O_2 .

Gounder and Vikas. (2016) study used three different type of impression material that is addition silicone, Aluwax and polyether and three disinfectant 0.5% chlorhexidine gluconate, 1% sodium hypochlorite, and 2% glutaraldehyde Theis study used both spray method and immersion method. Least dimensional change showed in that previous study was range from (0.024% to 0.005%).his present study shows least changes in length of addition reaction silicone material after disinfection with 3% H_2O_2. The result is non-significant in this present study.

In this present study Table II- shows that the mean value of changed width of the addition silicon impression material after disinfecting with 1% NaOCL and 3% H_2O_2 were 0.185 and 0.256 respectively. However, more changes were observed in 3% H_2O_2 (0.256±0.255) compare to 1% NaOCL 0.185±0.241). In 2009 Amin et al. reported that 0.5% sodium hypochlorite causes minimal dimensional changes in addition reaction silicone impression material in comparison to 1% NaOCL. This disinfectant showed smallest dimensional change of addition silicone about 0.0024%. The dimensional changes, however, were minimal and clinically insignificant. In this present study the difference is also non-significant. So the result of the study coincide with the result of Amin et al. 2009.

Pal et al. (2014) reported that 100% reduction of microorganisms as a result of immersing the impressions in 2% glutaraldehyde and 1% and 4% NaOCL without deteriorating the surface details when type IV stone plaster models were obtained. An important finding was that the impressions disinfected with 1% NaOCL had better quality in terms of surface details reproduction.

In this present study Table III- shows that the mean value of changed thickness of the addition silicon impression material after disinfecting with 1% NaOCL and 3% H_2O_2 were 0.178 and 0.158 respectively. However, more changes were observed in 1% NaOCL (0.178±0.196) compare to 3% H_2O_2 (0.158±0.158).A study by Al-Enazi and Naik (2016) reported that the efficacy of the disinfectants 1% sodium hypochlorite and 3% H_2O_2 on dentulous impressions using alginate and addition silicone impression materials were showed to be the most effective ones. Both of the disinfectant were used effectively for both alginate and addition reaction silicone impression material. In this present study difference is also statistically non significant. So this study is indicating that both the disinfectant are effective for disinfecting addition reaction silicone impression material.

In Figure-I shows that no significant difference in mean length, width and thickness of specimen in 1% NaOCL and 3% H_2O_2 ($p>0.05$) disinfectant solution. However, more changes of length were observed in 3% H_2O_2 (0.181±0.245) compare to 1% NaOCL (0.117±0.185); more changes of width were observed in 3% H_2O_2 (256±0.255) compare to 1% NaOCL (0.185±0.241). Regarding thickness more changes were observed in 1% NaOCL(0.178±0.196) compare to 3% H_2O_2 solution (0.158±0.158).

The results of the present study show that both the disinfectant 1% NaOCl and 3% H_2O_2 is very efficient disinfection solution and does not alter dimensional stability. Some author suggested that hydrophilic impression material causes imbibition so it is better to use spray method rather than the immersion. This study shows that spraying as a disinfection method causes optimal dimensional change in both 1% NaOCL and 3% H_2O_2 solution.

Conclusion

According to the results of this study, it is concluded that there is no significant difference in dimensional change of addition reaction elastomeric impression material after disinfecting with 1% NaOCl and 3% H_2O_2. So both of the disinfectant are effective for disinfecting addition reaction elastomeric impression material.

Appendix

Data Collection Sheet

Department of Prosthodontics

Faculty of Dentistry

Bangabandhu Sheikh Mujib Medical University

Specimen consists of addition reaction impression materials after disinfecting with 1% NaOCl prepared from a plexiglass mold (100mm x 10mm x 3mm).

Specimen consists of addition reaction impression materials after disinfecting with 3% H2O2 prepared from a plexiglass mold (100mm x 10mm x 3mm).

AB……/CD……/EF.....

AB=length of the specimen measured from the plexiglass mold

CD= width of the specimen measured from the plexiglass mold

EF= thickness of the specimen measured from the plexiglass mold

Data collection sheet (Appendix I)

Specimen Serial Number	Impression after disinfection with 1% NaOCl in mm			Impression after disinfection with 3% H_2O_2 in mm		
	AB	CD	EF	AB	CD	EF
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						

Specimen Serial Number	Impression after disinfection with 1% NaOCl in mm			Impression after disinfection with 3% H_2O_2 in mm		
	AB	CD	EF	AB	CD	EF
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						

The test of significance will be calculated and p values <0.05 will be accepted as level of significance.

Specimen of addition reaction impression material after disinfecting with1%NaOCl with 3 mm thickness

Specimen of addition reaction impression material after disinfecting with 3%H_2O_2 with 3 mm thickness

AB−length of the specimen measured from the plexiglass mold

CD− width of the specimen measured from the plexiglass mold

EF− thickness of the specimen measured from the plexiglass mold

Appendix ii

Statistical formula

1. Mean $(\bar{x}) = \frac{\sum x}{n}$

Where, $\sum x$ − Summation of individual observations

n− Number of observations

2. Standard deviation:

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

σ − Standard deviation

∑ = Sum of

X = each value in the data set

= mean of all values in the data set

n − number of value in the data set

3. Two sample t-test (Unpaired t-test)

$$t = \frac{m_1 - m_2}{\sqrt{SE_1^2 - SE_2^2}} \qquad df = (n_1 - 1) + (n_2 - 1)$$

m_1= mean of group I, m_2= mean of group II,

SE_1= SE of group I, SE_2= SE of group II,

n_1= Sample size of group I, n_2= Sample size of group II

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