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EVALUATION OF SURFACE QUALITY AND DIMENSIONAL ACCURACY OF ELASTOMERIC IMPRESSION MATERIALS AFTER VARIOUS DISINFECTION PROTOCOLS

Prosthodontics

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ABSTRACT

To evaluate surface quality and dimensional accuracy of elastomeric impression materials after various disinfection protocols. A Total of 150 samples were made i.e..50 from each type of impression material. Specimens were immersed in disinfectant solutions namely 0.2% chlorhexidine,5.25% hypo,0.2% povidone iodine, running tap water and ozone water for disinfection and examined for surface quality using stereomicroscope and dimensional accuracy using digital Vernier calipers. Silicones exhibited best dimensional accuracy & surface quality when treated with ozone water after 24 hours of disinfection whereas polyether exhibited good surface quality & dimensional accuracy when treated with control (tap water) after 24 hours of disinfection.

KEYWORDS

Elastomers, Stainless steel die, Disinfectants.

INTRODUCTION

During routine dental procedures, dental professionals are exposed to various contaminants from blood and saliva either directly or indirectly.Majority of these organisms results into significant risk to dental professionals such as hepatitis, HIV etc..[1]

To reduce this risk, dental impressions must be disinfected after their removing from oral cavity before they are sent to the laboratory for prosthesis fabrication. Even though the importance of dental impression disinfection is still highlighted and its performance according to manufacturer instructions should ensure almost 100% antimicrobial decontamination, this step is often underestimated and the education in this area is still not sufficient.

The most frequently used chemical disinfectants are glutaraldehyde, formaldehyde, alcohol, iodine solution, synthetic phenol, sodium hypochlorite and other chlorine releasing solutions.

Studies conducted by Ahila *et al*. (2012) showed no significant dimensional changes following disinfection of silicone impressions. During the detail, reproduction evaluation of consistent rating of 1 was recorded for all specimens.[8] Studies conducted by Amin et al showed that addition and condensation silicone displayed superior qualities in terms of dimensional stability and surface quality.[9] Studies conducted by saber et al showed that disinfection by iodophor resulted in more dimensional changes compared to sodium hypochlorite.[7]

This study is based on evaluation of surface quality and dimensional accuracy of elastomeric impression materials after various disinfection protocols.

MATERIALS AND METHODS:

A Total of 150 samples were made i.e..50 from each type of impression material-Addition silicone, Condensation silicone and Polyether. Specimens were immersed in disinfectant solutions- 0.2% chlorhexidine, 5.25% hypo, 0.2% povidone iodine, running tap water and ozone water for disinfection and examined for surface quality using stereomicroscope and dimensional accuracy using digital Vernier calipers.

DIE SPECIFICATIONS:

A stainless steel die was prepared according to ADA specification number 19 with length 31mm, outer and inner diameter 38mm and 29.97mm and height of inner diameter 3mm.

It consists of 3 horizontal parallel lines named as X, Y, Z -Distance between each line is 2.25mm.

It consists of 2 parallel vertical lines-AB and A□B□-Distance between each line is 25mm.

Die consists of a ring which acts as a mold of 6mm height with outer and inner diameter 38mm and 30mm respectively.

SAMPLE PREPARATION:

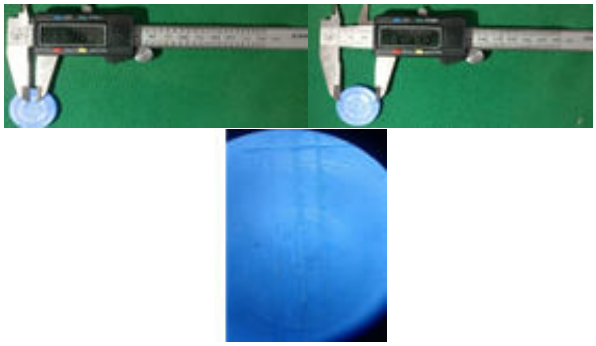
A total of 150 samples were made from each type of impression material i.e..50 samples from addition silicone,50 samples from condensation silicone and 50 samples from polyether material.

DISINFECTION:

These samples which were prepared were subjected to disinfection with different disinfectants and checked for surface quality and dimensional accuracy for 15 minutes,24 hours and 48 hours respectively using immersion technique.

Of 50 samples from different impression materials,10 samples were disinfected in ozone water,10 samples in regular tap water,10 samples hypo,10 samples in chlorhexidine and 10 samples in povidone iodine. After 5-10 minutes of disinfection, all samples were taken off from respective disinfectants and checked for surface quality and dimensional accuracy using stereomicroscope and digital vernier calipers respectively within 15 minutes,24 hours and 48 hours of disinfection.

MEASUREMENT OF SURFACE QUALITY AND DIMENSIONALACCURACY:



MEASUREMENT OF DISTANCE BETWEEN X,Y,Z LINES USING VERNIER CALIPERS

SURFACE QUALITY RATINGS:

Surface qualities of samples were measured using stereomicroscope of

10X magnification. Ratings were given to each sample based on detail reproduction of impression material in stereomicroscope.

Score 1: Well-defined sharp detail and continuous line.
Score 2: Continuous line but with some loss of sharpness.
Score 3: Poor detail or loss of continuity of line.
Score 4: Marginally or completely not discernible line.

Table 1,2 Showing Dimensional Changes Of Different Samples In Different Disinfectant Solutions For 15 Minutes,24 Hours And 48 Hours Of Disinfection,when They Are Checked With Digital Vernier Calipers.

Table 1:

	Addition			Condensation			Polyether		
	15 min	24 hrs	48 hrs	15 min	24 hrs	48 hrs	15 min	24 hrs	48 hrs
	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
HYPO									
X-Y (In mm)	2.29 ± 0.06	2.27 ± 0.09	2.27 ± 0.11	2.60 ± 0.24	2.53 ± 0.18	2.44 ± 0.19	2.79 ± 0.10	2.69 ± 0.16	2.39 ± 0.10
Y-Z (In mm)	2.29 ± 0.04	2.22 ± 0.11	2.26 ± 0.06	2.52 ± 0.25	2.55 ± 0.17	2.48 ± 0.17	2.79 ± 0.10	2.67 ± 0.15	2.41 ± 0.11
Z-X (In mm)	4.43 ± 0.16	4.38 ± 0.05	4.38 ± 0.12	4.70 ± 0.12	4.66 ± 0.16	4.45 ± 0.18	4.86 ± 0.09	4.66 ± 0.13	4.43 ± 0.13
AB-A'B' (In mm)	24.62 ± 0.04	24.62 ± 0.08	24.54 ± 0.11	24.34 ± 0.29	24.39 ± 0.13	24.35 ± 0.11	24.47 ± 0.23	24.59 ± 0.26	24.42 ± 0.19
χ Value	33.088	33.101	32.993	33.073	33.013	33.030	32.995	33.001	33.076
P Value	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*
BETADINE									
X-Y (In mm)	2.26 ± 0.01	2.26 ± 0.01	2.26 ± 0.02	2.59 ± 0.07	2.48 ± 0.17	2.50 ± 0.05	2.65 ± 0.14	2.45 ± 0.09	2.44 ± 0.15
Y-Z (In mm)	2.26 ± 0.01	2.25 ± 0.01	2.27 ± 0.01	2.59 ± 0.07	2.43 ± 0.17	2.58 ± 0.10	2.65 ± 0.14	2.48 ± 0.17	2.48 ± 0.17
Z-X (In mm)	4.37 ± 0.03	4.44 ± 0.06	4.40 ± 0.07	4.69 ± 0.23	4.73 ± 0.18	4.73 ± 0.18	4.87 ± 0.18	4.83 ± 0.13	4.33 ± 0.13
AB-A'B' (In mm)	24.63 ± 0.09	24.62 ± 0.08	24.68 ± 0.04	24.48 ± 0.27	24.41 ± 0.12	24.74 ± 0.17	24.40 ± 0.25	24.61 ± 0.22	24.75 ± 0.24
χ Value	33.091	33.470	33.397	33.006	33.257	33.789	33.001	33.002	33.033
P Value	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*

Kruskal Wallis Test: *P < 0.05 (significant), **p > 0.05 (Not significant)

Table 2:

	Addition			Condensation			Polyether		
	15 min	24 hrs	48 hrs	15 min	24 hrs	48 hrs	15 min	24 hrs	48 hrs
	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
CHLORHEXIDINE									
X-Y (In mm)	2.27 ± 0.07	2.26 ± 0.08	2.25 ± 0.02	2.59 ± 0.25	2.51 ± 0.13	2.37 ± 0.03	2.68 ± 0.25	2.64 ± 0.23	2.45 ± 0.09
Y-Z (In mm)	2.27 ± 0.05	2.27 ± 0.05	2.27 ± 0.01	2.59 ± 0.25	2.58 ± 0.15	2.52 ± 0.11	2.68 ± 0.25	2.63 ± 0.18	2.50 ± 0.07
Z-X (In mm)	4.36 ± 0.06	4.36 ± 0.03	4.35 ± 0.02	4.75 ± 0.17	4.58 ± 0.11	4.61 ± 0.06	4.84 ± 0.19	4.53 ± 0.15	4.51 ± 0.15
AB-A'B' (In mm)	24.63 ± 0.05	24.62 ± 0.04	24.65 ± 0.06	24.23 ± 0.47	24.43 ± 0.21	24.48 ± 0.19	24.21 ± 0.15	24.61 ± 0.18	24.71 ± 0.17
χ Value	33.072	33.104	33.054	33.017	32.861	33.076	33.033	32.972	32.934
P Value	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*
CONTROL									
X-Y (In mm)	2.25 ± 0.03	2.28 ± 0.04	2.30 ± 0.05	2.25 ± 0.03	2.78 ± 0.07	2.76 ± 0.03	2.25 ± 0.03	2.34 ± 0.07	2.35 ± 0.05
Y-Z (In mm)	2.25 ± 0.03	2.25 ± 0.04	2.30 ± 0.01	2.25 ± 0.03	2.71 ± 0.03	2.71 ± 0.03	2.25 ± 0.03	2.30 ± 0.04	2.31 ± 0.04
Z-X (In mm)	4.38 ± 0.03	4.38 ± 0.02	4.39 ± 0.02	4.18 ± 0.03	4.54 ± 0.03	4.57 ± 0.03	4.38 ± 0.03	4.41 ± 0.01	4.43 ± 0.04
AB-A'B' (In mm)	24.63 ± 0.08	24.64 ± 0.02	24.65 ± 0.01	24.30 ± 0.03	24.42 ± 0.07	24.51 ± 0.03	24.63 ± 0.09	24.66 ± 0.02	24.65 ± 0.00
χ Value	19.000	33.555	34.175	39.000	33.207	31.786	19.000	33.555	34.175
P Value	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*

Kruskal Wallis Test: *P < 0.05 (significant), **p > 0.05 (Not significant)

Table 3:

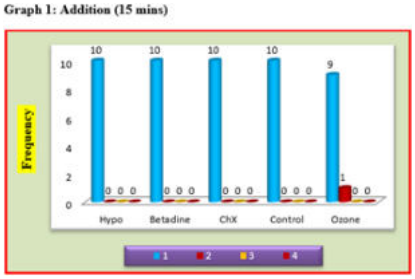
	Addition			Condensation			Polyether		
	15 min	24 hrs	48 hrs	15 min	24 hrs	48 hrs	15 min	24 hrs	48 hrs
	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
OZONE									
X-Y (In mm)	2.27 ± 0.02	2.30 ± 0.07	2.32 ± 0.06	2.70 ± 0.11	2.40 ± 0.09	2.56 ± 0.06	2.48 ± 0.14	2.48 ± 0.18	2.56 ± 0.22
Y-Z (In mm)	2.28 ± 0.02	2.27 ± 0.05	2.28 ± 0.05	2.70 ± 0.11	2.42 ± 0.11	2.52 ± 0.12	2.47 ± 0.17	2.51 ± 0.14	2.52 ± 0.14
Z-X (In mm)	4.38 ± 0.02	4.42 ± 0.05	4.44 ± 0.03	4.85 ± 0.14	4.62 ± 0.18	4.64 ± 0.17	4.55 ± 0.14	4.59 ± 0.14	4.61 ± 0.14
AB-A'B' (In mm)	24.63 ± 0.04	24.62 ± 0.06	24.64 ± 0.05	24.44 ± 0.22	24.45 ± 0.25	24.47 ± 0.24	24.54 ± 0.25	24.54 ± 0.13	24.65 ± 0.13
χ Value	33.294	33.418	33.764	32.898	33.027	33.234	32.983	32.900	33.030
P Value	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*	< 0.001*

Kruskal Wallis Test: *P < 0.05 (significant), **p > 0.05 (Not significant)

Table 3 Showing Dimensional Changes Of Different Samples In Different Disinfectant Solutions For 15 Minutes,24 Hours And 48 Hours Of Disinfection, When They Are Checked With Digital Vernier Calipers.

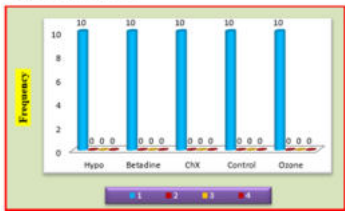
RESULTS:

Graph 1: Addition (15 mins)



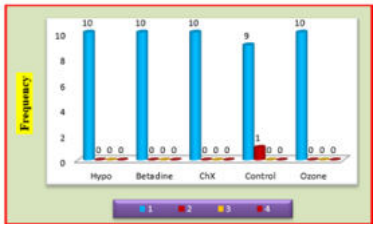
Graph 1 Showing Surface Quality Of Addition Silicone With Different Disinfectants After 15 Minutes Of Disinfection

Graph 2: Addition (24 hrs)



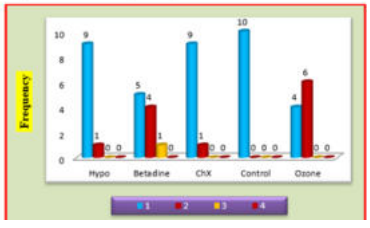
Graph 2 Showing Surface Quality Of Addition Silicone With Different Disinfectants After 24 Hours Of Disinfection

Graph 3: Addition (48 hrs)



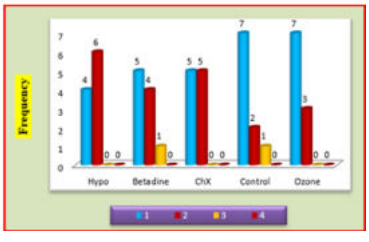
Graph 3 Showing Surface Quality Of Addition Silicone With Different Disinfectants After 48 Hours Of Disinfection

Graph 4: Condensation (15 mins)



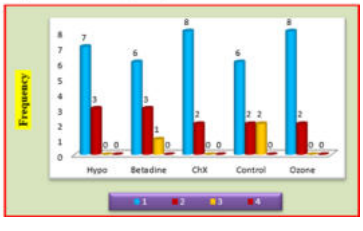
Graph 4 Showing Surface Quality Of Condensation Silicone With Different Disinfectants After 15 Minutes Of Disinfection

Graph 5: Condensation (24 hrs)



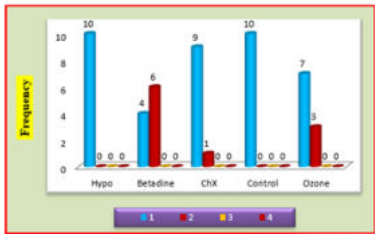
Graph 5 Showing Surface Quality Of Condensation Silicone With Different Disinfectants After 24 Hours Of Disinfection

Graph 6: Condensation (48 hrs)

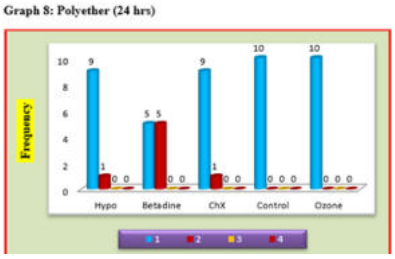


Graph 6 Showing Surface Quality Of Condensation Silicone With Different Disinfectants After 48 Hours Of Disinfection

Graph 7: Polyether (15 mins)



Graph 7 Showing Surface Quality Of Polyether With Different Disinfectants After 15 Minutes Of Disinfection



Graph 8 Showing Surface Quality Of Polyether With Different Disinfectants After 24 Hours Of Disinfection

DISCUSSION:

According to ADA Specification number 19, elastomeric impression materials should not exhibit more than 0.5% dimensional change within first 24 hours. In this study, ANOVA was used to check dimensional accuracy and surface quality of elastomers. The reason of using ANOVA is it is used to measure variance between 2 or more variables.

Hence from the statistical analysis, it was concluded that of all the disinfectants used, silicones exhibited best dimensional accuracy & surface quality when treated with ozone water after 24 hours of disinfection whereas polyether exhibited good surface quality & dimensional accuracy when treated with control (tap water) after 24 hours of disinfection.

Of all elastomeric impression materials, Polyether was found to be statistically significant ($p<0.05$) i.e. least dimensional change exhibited after 48 hours of disinfection.

Addition silicone exhibits greater dimensional stability, less polymerization shrinkage and and no volatile by products released.

Condensation silicone dimensional stability is not good due to large polymerization shrinkage and loss of volatile byproduct. Polyether is said to be dimensionally good as it has no byproducts and it has less polymerization shrinkage.

Advantage of using digital vernier calipers rather than manual one is it reduces man-made errors and its is a highly precised instrument with great accuracy.

An ideal disinfectant should be capable of rapidly killing pathogenic microorganisms and should not be toxic or destructive to the materials disinfected. It should be reasonably priced and simple to use. NaOCl (prime dental product) is economical and effective in dilute solutions. The 10-minute disinfection time for the 5.25% sodium hypo-chlorite immersion disinfection was selected according to ADA specifications. Advantages of NaOCl are least expensive, readily available, 100% effective and fast acting broad spectrum disinfectant according to ADA's protocol.[5]

Chlorhexidine is a bis-biguanide active against both gram positive and gram negative organisms.

Povidine iodine is active against bacteria, virus, spores and fungi.[6]

Ozone, as a new, environment friendly, alternative dental impression disinfectant seems to be highly promising, designating and time saving method, without the need of consumable materials, which can be applied in every dental office since it requires limited space. The 5-minute ozone disinfection time was selected which showed efficient disinfection results.[4]

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