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Effect of certain disinfecting solutions and surfactant on the wettability of silicone rubber impression materials

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Abstract

Back ground: All dental impressions should be disinfected before pouring to control cross contamination but disinfection may affect impression wettability. This study evaluated the effect of disinfection and the use of surfactant agent on the wettability of some silicone impression materials by contact angle registration of the gypsum slurry on flat surfaces of the impressions.

Materials and methods: addition silicone regular body –automixing type- and condensation silicone (light body)with two types of disinfecting solutions 0.2% chlorhexidine gluconate and 1% povidone iodine for two disinfecting times and one surfactant agent (soap) were used in this study. Three treatment regimes were investigated: The first group of impression materials specimens was exposed to saliva for 5 minutes (control group). Second group of specimens was exposed to saliva then to disinfectant agents, and third group of specimens was exposed to saliva, disinfectants and surfactant agent (experimental groups), a computerized photographic procedure was used to measure the wettability of the specimens. Statistical analysis was performed by using t-est at $p<0.05$.

Results: the results revealed that treatment with 0.2% chlorhexidine gluconate as a disinfectant alone or when tested with the surfactant improved the wettability of addition and condensation silicones at 30min. disinfection time ,but surfactant coating of disinfected condensation silicone produced a significant increase of the mean values at 60min. disinfection time. While treatment with 1% povidone iodine disinfectant increased the mean contact angles for both addition and condensation silicones significantly. Same result was seen when povidone iodine was used in combination with the surfactant.

Conclusion: disinfection with 0.2% chlorhexidine gluconate produced a high-energy impression surfaces for both addition and condensation silicones.

Introduction

Dental impressions represent a potential transmitter of microorganisms and infection. To avoid contamination of dental office staff and dental technicians , it has been recommended to disinfect impressions immediately after their removal from the mouth by immersion or spraying with disinfectant agents [1, 2].

Silicone impression materials have gained popularity among dentists, they

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exhibit very good accuracy, together with an absence of taste and easy de-molding. One problem with the use of these materials is bubble formation during pouring of the impressions. Voids formation in gypsum models has been related to the wettability of the impression material by calcium sulfate [3-6].

Surface properties of impression materials play an important role in producing an accurate replica of the oral structures , the low surface energies of organic and most in organic liquids permit them to spread freely on solids of high surface energy thus, formation of a strong adhesive joint requires good wettability. The extent to which an adhesive wets the surface of an adhered may be determined by measuring the contact angle between the adhesive and the adherent [3]. Some dental laboratories spray the cured impression with a surfactant solutions just prior to pouring the model to increase the wettability of the impressions[6].

Several studies showed that the choice of the most effective surfactant is critical and differs not only between types of elastomers but also between brands of a single Type [7, 8].

Norling BK, 1979 [9] found that incorporation of certain non ionic surfactants into silicone and polysulfide elastomers increase their wettability .

In 2004 Khalid [10] concluded that sterilization of rubber impressions either by immersion in 2% gluteraldehyde or by micro wave energy seems to be suitable technique for sterilizing rubber impressions and that application of topical surfactant helped restore wettability of sterilized impressions.

Materials and methods

The impression materials used in this study were addition silicone, hydrophilic regular body (auto mixing) and condensation silicone hydrocompatible light body (Zhermach clinical) .The materials were manipulated according to manufacturer's instructions.

According to ADA specification No. (18) test molds were made from plastic rings 30 mm inside diameter and 16 mm high. The impression materials were applied within the test molds; a flat surfaces were obtained by pressing the mold against well cleaned and dried a glass slab. The specimens pressed by using 1/2 kg weight to squeeze out the excess material till the specimens set.

Regarding each tested impression material, four specimens were produced for the control and every experimental group. The treatment regimes were as follows:

Group I (control group) involved specimens exposed to diluted saliva (50% saliva in distilled water) for 5 minutes, then rinsed with distilled water and air dried.

Group II involved specimens exposed to diluted saliva for 5 minutes, then rinsed under distilled water and air dried. Then the specimens (addition and condensation silicones) were immersed in the disinfecting solutions (0.2% chlorhexidine gluconate or 1% povidone iodine) for either 30min. or 60 minutes. Finally, the specimens were rinsed under distilled water and air dried.

Group III involved specimens that were exposed to diluted saliva for 5 minutes, then rinsed with distilled water and air dried. The specimens were immersed for 30 or 60 minutes in each one of disinfecting agents (0.2% chlorhexidine gluconate or 1%

povidone iodine), rinsed with distilled water, dried by air. The specimens were coated with the surfactant. The surfactant used in this study was soap as anionic surfactant dissolved in water (30g of soap powder mixed with 100ml of tap water) , the specimens were dried with compressed air.

According to ADA specification No. (18), gypsum slurry was prepared (100g of gypsum powder was mixed with 30ml of distilled water to produce a mixture of a workable consistency). Three droplets of 10 µL were dispensed on the surface of the impression specimens by using a micro pipette, figure (1). The droplets were left for 10 seconds then direct reading of the contact angle was performed with a computerized photographic procedure and AUTO CAD program, figure (2).

Descriptive data include means and standard deviation was used in the statistical analysis. Comparison between groups was done by using T-test at $p<0.05$.

Results

Means and standard deviation of the registrated contact angles for the control and experimental groups are shown in table (1). Data indicated that addition silicone recorded lower mean contact angles than the condensation silicone used in this stud.

Table (2) showed a comparison between the control and experimental groups of the impression materials disinfected with chlorhexidine gluconate. The disinfection of addition silicone in CHX produced insignificant increase in the mean contact angle measurements at both disinfection times, while treatment of the disinfected specimens with the surfactant affect the contact angle measurements by insignificant reduction. Disinfection of condensation silicone in CHX produced a significant reduction of the mean values at both disinfecting times than the control group.

Coating of the disinfected specimens with the surfactant showed a significant reduction of the mean contact angle values after 30 min. disinfection , while disinfection of the specimens for 60 min. and followed by surfactant application increased the mean contact angle registration significantly, table(2).

Table (3) showed a significant increase in contact angle values after disinfection of addition and condensation silicones with povidone iodine, also treatment of the disinfected specimens with soap surfactant revealed a significant increase in contact angle values than the control group at both disinfection times, table (3).

Table (4) showed that application of soap surfactant to the CHX disinfected addition silicone revealed a non significant reduction in the mean angle values at both disinfection times. Surfactant coating of the other disinfected specimens increased the contact angle values either (significant or in significant increased of mean angle values).

Discussion

Under clinical conditions impression materials are exposed to saliva during setting in the oral cavity. When impressions are retrieved, they are covered by a thick salivary film and sometimes blood. In view of prophylaxis against infections, all impressions should be disinfected before pouring but disinfection procedure might affect their wettability [14,15] . Wettability of impression materials can be improved by topical surfactant application. Surfactants are referred to as wetting agents, they lower the surface tension of the impressions [10,17].The wettability of impression materials has previously been described by determining the contact angles of gypsum products or CaSo4 solutions on the impressions [18].

Results of this investigation indicated that the contact angle values varied according to disinfecting agent type. Disinfection of addition and condensation silicones with 0.2% chlorhexidine gluconate improved the wettability of the materials, this finding could be attributed to the activity of CHX as a disinfectant as well as a surfactant agent this result was in agreement with findings of Reshad [11] and Oshima [12]. Also treatment of CHX disinfected addition silicone with soap surfactant improved the wettability of silicones than the control group, the slight reduction of the mean contact angles could be attributed to the slight activity of soap as a surfactant, because the anionic surfactants react in the wash water (tap water) with the positively charged water hardness ions (calcium and magnesium) which can lead to partial deactivation of soap [17], or might be due to that the anionic surfactant like soap deactivate the action of chlorhexidine as a surfactant agent [20]. The significant increase in contact angle means was observed after application of surfactant to the CHX disinfected condensation silicone at 60min. disinfection time, this could be explained that prolonged disinfection time for condensation silicone adversely affected the wettability of the material.

The contact angles of addition and condensation silicones in the povidone iodine were significantly higher than those of the control group at both disinfecting times ($p<0.05$), this result was not in agreement with Soo [8] who showed that short disinfection time with povidone iodine decrease contact angles of silicone impressions. The same result was obtained when the disinfected samples were coated with surfactant , this might be due to deactivation of soap as a surfactant by presence of calcium and magnesium ions in tap water [17]. Regarding the comparison between experimental groups for each disinfecting time before and after surfactant application, the results revealed that there was an increase in contact angle values of the disinfected silicones after soap application, this finding was not in agreement with Kess [15] and Kenneth [16]. While CHX disinfected addition silicone showed statistically in significant reduction of the mean contact angles after surfactant application, This finding could be related to the combined action of CHX as a disinfectant and as a surfactant agent also it could be related to the hydrophilicity of the addition silicone used in this study. This finding was in agreement with Khamis [13], who showed that short disinfection time produced the greatest improvement in the wettability of elastomeric impression materials.

Conclusion

Immersion disinfection of silicone impressions (regular addition and light condensation silicones) in 0.2% chlorhexidine gluconate is recommended in preference to maintain wettability of silicone rubber impression materials for short disinfection time also application of topical surfactant dissolved in tap water affect the contact angle values of both silicones either in significantly different or significantly higher than the control group.

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Table (1): Means and standard deviation of the contact angle measurements for the control and experimental groups of each impression material.

	Control	CHX		Povidone Iodin.		CHX&Surfactant		Iodi &Surfactant	
		30min.	60min.	30min.	60min.	30min.	60min.	30min.	60min.
Addition	62.21 12.92	68.44 8.34	62.66 6.64	79.35 .05	84.88 2.74	60.88 9.29	59.94 7.55	84.2 3.2	85.88 3.37
Condensation	73.93 5.14	66.83 11.11	67.16 11.6	78.6 7.77	82.72 7.56	70.8 10.19	76.1 9.85	80.99 9.2	88.3 11.3

CHX: chlorhexidine gluconate. Iod.: povidone iodine.

Table (2): T-test between the control and the CHX groups regarding addition and condensation impression materials for the two testing periods.

	CHX				Surfactant&CHX			
	30min		60min		30min.		60min.	
	t-value	Sig.<0.05	t-value	Sig<0.05	t-value	Sig.<0.05	t-value	Sig.<0.05
Addition	1.31	0.8(N.S)	0.105	0.2(N.S)	0.264	0.8(N.S)	0.5	0.49(N.S)
Condensation	1.42	0.000 (S)	1.64	0.04 (S)	1.03	0.04 (S)	0.15	0.03 (S)

NS:insignificant difference **S**:significant difference

Table (3): T-test between the control and the Povidone Iodine groups regarding addition and condensation impression materials for the two testing periods

	Povidone Iodin				Surfactant &Povidone Iodin			
	30min		**60min**		**30min.**		**60min.**	
	t-value	Sig.<0.05	t-value	Sig.<0.05	t-value	Sig.<0.05	t-value	Sig.<0.05
Addition	4.91	0.000(HS)	6.56	0.000(H.S)	5.65	0.000(H.S)	6.25	0.000(H.S)
Condensation	0.88	0.04(S)	2.06	0.009(S)	1.34	0.04(S)	2.59	0.03(S)

Table (4):Comparison between experimental groups regarding disinfection types, times and impression materials before and after surfactant treatment.

	CHX&(CHX +Surfactant)				Iodine&(Iodine+Surfactant			
	30min		60min		30min		60min	
	T-value	**Sig.<0.05**	T-value	**Sig.<0.05**	**T-value**	**Sig.<0.05**	**T-value**	**Sig.<0.05**
Addition	1.47	0.7 (NS)	0.673	0.40(NS)	1.08	0.04 (S)	0.38	0.46(NS)
Condensation	6.45	0.38(NS)	0.15	0.02(S)	0.48	0.69(NS)	1.19	0.63(NS)

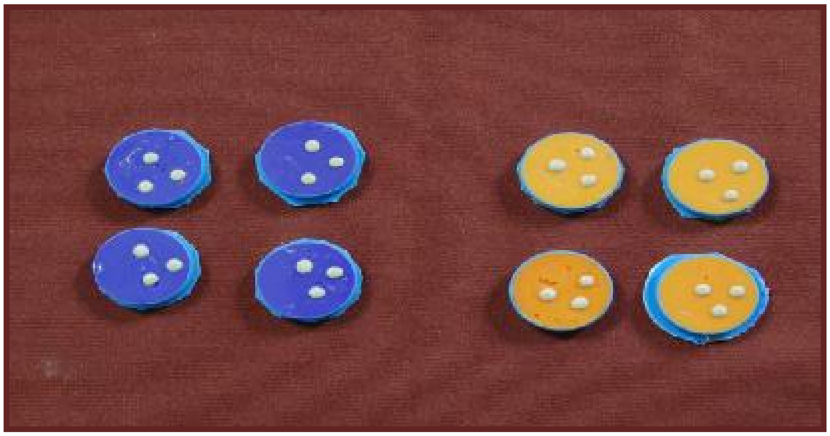
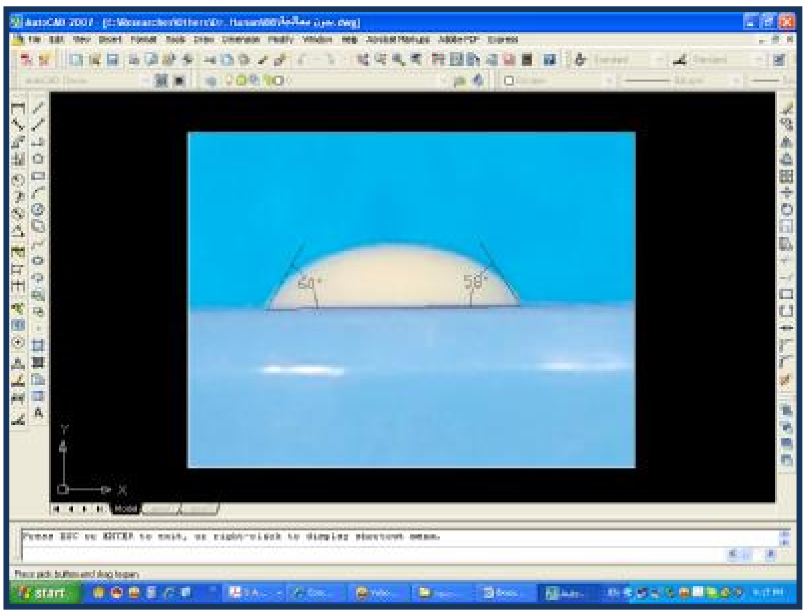


Figure (1) :-Impression specimens with slurry droplets of dental stone.



Figure(2):-Computerized photograph illustrates contact angle measurement with AUTO CAD program.