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The effect of disinfection procedure and storage on wettability of hydrophilized condensation silicone impression materials

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Abstract

Background: a newly developed hydrophilized condensation silicone impression material claimed to be hydrophilic, but exposure to disinfection procedure and storage could alter the wettability of impression material. Thus, the aim of present study was to evaluate the effect of impression disinfection by immersion in 0.5% NaOCl for 10 mints. on wettability of hydrophilized condensation silicon . In addition, effect of storage after disinfection for two hours, measured by contact angle of dental stone mix with impression surface.

Materials and Methods: Hydrophilized condensation silicone (putty and wash type) tested with type III dental stone and 0.5% sodium hypochlorite disinfectant solution were used in this study. Disinfection procedure by immersion for 10 mint. Wettability was evaluated in simulation of regular clinical situation pouring 2ml. of stone slurry on impression surface to form stone patty. Each patty sectioned into two halves, scanned with flat bed scanner and images printed.

Dental stone mix contact angle with impression surface was measured with protractor from scanned image of the cross section of stone patty. Measurements were preformed before and after disinfection procedure, also after storage in humid environment for two hours.

Results: The putty type showed significant difference $p<0.001$ when subjected to disinfection and storage. The wash type showed no significant difference $p>0.05$ when subjected to disinfection or storage. Both types together they were not affected by disinfection procedure $p>0.05$, but storage had significant effect $p<0.001$ on wettability.

Conclusions: For the hydrophilized condensation silicone using both types together (putty + wash) for making impression improve wettability even after disinfection. Delay pouring impression for two hours cause deterioration of impression wettability.

Keywords: wettability, impression material, surfactant, disinfection, hydrophilicity.

Introduction

Silicon impression materials are the materials of choice for recording impression that require a high degree of accuracy [(1)]. In prosthodontics all impression that have been exposed to infected saliva and blood pose a main source of cross-contamination and additional problems in controlling

cross-infection between dental office and laboratories [2]. Silicon impression materials, in contrast to the clinical requirements, they are hydrophobic in nature, which can be related to their polar backbone chemistry [3, 4]. This means they are not easily wetted by gypsum mix, which may lead to entrapment of air during pouring the impression. When gypsum products mixes are poured into hydrophobic silicon impression, high contact angles are formed, making casts that are bubble-free difficult [5], hence may affect precision of impression [6].

To overcome this shortcoming, manufacturers add surfactants to these materials to improve their hydrophilicity [7]. Surfactant are added to reduce surface tension of water surface , contact angle ,improve wettability and simplify the pouring of gypsum models [5]. The wettability of set impression surface is determined by measuring the magnitude of the contact angle formed with stone mix or with water droplet [8, 9, 10, 11].

Disinfection of impression by immersion considered to be more reliable method which should ensure amore even contact between the disinfectant and impression [12, 13].

Different brands of silicon impression materials have different wetting properties and contact angle measurements [14]. Several studies have shown that disinfection procedure affect wettability of silicon impression materials with variable degrees [11, 10]. Delay pouring of impression or storage is required to allow material to recover elastically after being separated from the under cut of the mouth [15]. Additionally, delay may be necessary to permit the release of by-product that can influence properties of the stone die [16]. The wettability of impression after disinfection and storage is important in some situation when impression not received immediately by the dental technician. Elastomeric impression material have been used over several decades in the field of prosthodontics to reproduce hard and soft tissue details and to fabricate an accurate replica [17] . Condensation silicon impression materials are known to be hydrophobic, but manufacturers added surfactants (as denoted by the wording hydrophilized) is (non-ionic)soap-like materials that provide enhanced wetting of hydrophobic surfaces by aqueous fluids [18].

Thus, the aim of present study was to evaluate the effect of impression disinfection by immersion in 0.5% NaOCl for 10 mints. On wettability of hydrophilized condensation silicon. In addition, effect of storage after disinfection for two hours, measured by contact angle of dental stone mix with impression surface.

Materials and methods

The impression materials used in this study were hydrophilized condensation silicon (c-silicon) impression material (Zetaplus putty,Oran washVL hydrophilic,Zhermack/45021 Badiapolesine (Rovigo),Italy) tested with Type III dental stone (elite model type 3 ,Zhermack/45021 Badiapolesine (Rovigo),Italy) using water/powder ratio 30ml/100g according to manufacturer instruction .

Disinfection procedure as recommended by manufacturer, American dental Association and previous studies [13], through immersion disinfection for 10 mint. In 0.5% sodium hypochlorite NaOCl (Fas 6% Babel company, Baghdad Iraq) diluted to 0.5%. Sample grouping are listed in table (1).

Testing wettability**:**

To test wettability of the impression surfaces was evaluated in simulation of the normal practice

situation, pouring stone slurry against impression surfaces [8, 9,10] . Customized tray made from auto polymerized acrylic resin with dimensions (10x6x0.5cm) to carry the impression materials. Equal amount (2ml each) of mixed dental stone were then dispensed using disposable plastic syringe (after removal of its narrow tip) over the impression surface while vibrating for 2sec. to form equal sized patties, after 30mint. each patty was released from impression sectioned using a saw into 2 halves Fig 1(A ,B ,C).

The contact angles of dental stones made with the impression surface were measured. The cross-sections of one half of each sectioned patty fixed with putty impression on custom tray and scanned on flat bed scanner (Genix,china) at dpi 1200 the image saved as JPG format and then printed.(Fig.2 **)**

The contact angles represented by cross-section all edges of each stone patty were measured by the use of a protractor Fig (3 A, B).

The data obtained from the study was subjected to both descriptive and analytic statistics.

The T-test was used to evaluate the significant of difference between each pair of groups for effect of disinfection and storage on wettability of hydrophilized condensation silicon, using a significance level of 5%. All computations were conducted with Spss software version18.

Results

Descriptive statistics of results of stone mix contact angle measurements with impression surface including mean and standard deviations are shown in Table 2.

For all groups in general whether control or experimental group, both types together (putty +wash type) have lower contact angle than each type alone except for storage group Table 2. However in disinfection group, both types have lower mean of contact angle value (B3 = 18.38) than control (A3 = 21.25) and storage group (C3 = 28.75) Fig 4.

In Table 3 Student's T-test shown significant difference ($p < 0.001$) for putty type groups (A1, B1, C1) when subjected to disinfection (B1) and then storage (C1) also comparing storage with disinfection group.

While wash type groups (A2, B2, C2) shown no significant difference $p > 0.05$ when subject to disinfection (B2) then storage (C2) also comparing storage with disinfection group.

On the other hand, both types together react differently than each type alone. Together they are not affected by disinfection procedure (A3 with B3) p value = 0.069 ($p > 0.05$) showed no significant difference. However, comparison between control and storage group (A3 with C3) showed significant difference $p < 0.001$, also comparison between disinfection and storage group (B3 with C3) showed significant difference $p < 0.001$ Table 3.

Discussion

Wettability can be defined as the ability of a liquid or water mixture (as fresh mix of dental stone) to spread over the surface of a solid (as impression surface) [19].

Wettability can be measured directly using several method including sessile drop method (contact angle formed between liquid & surface in question**)** [20] also measuring the contact angle of mixes of dental stone on impression surface [8, 9, 10]. The present study perform the later method which seems to be realistic ,because it reflects the exact situation of pouring and measures the contact angle of

mixed stone itself , not gypsum slurry against impression surface [9 ,10]. The wettability of impression materials is important because it has been shown to be related to the number of bubbles that form in dies poured from the material [21].

Impression materials must be disinfected subsequent to removal from the patient mouth and prior to being poured for casts [22]. Previous studies showed that disinfection procedure cause alteration of the wetting characteristics of the impression material and potential problems in obtaining a bubble –free cast [23, 24].

The disinfection procedure performed in this study by immersion in 0.5% NaOCL for 10 mints is recommended by manufacture and previous studies [25, 5].

Descriptive statistics of the results appear in Table 2. For all groups except for storage group revealed that both types together (putty + wash type) have lower stone mix contact angle means better wettability. The scientific explanation for this result is due to intrinsic surfactant in each material that release to the surface causing higher concentration of surfactant at the surface of the impression [18] decreasing dental stone mix contact angle. For the storage group probably delay pouring for two hours causes surfactant to evaporate leading to increase contact angle of stone mix.

Contact angle measurements of stone mix on surface of impression for all samples in the study where below 90º which considered wetting surface (hydrophilic) as stated by [26, 27]. Disinfection procedure performed reduced contact angle of stone mix significantly against putty type (A1 with B1) p <0.001 A1 mean value = 34.75 B1= 22.63. However disinfection procedure no significantly affect contact angle against wash type or both types together (A2 with B2) p value 0.75 p> 0.05 , (A3 with B3) p value 0.069 p > 0.05 Table 3.

This finding in agreement with Al-Jubori [24] who indicated that short immersion time not affect wettability also in agreement with Lepe et. al. 1995 and Toh et. al. 1987 [28, 29].

Immersion disinfection of putty type leads to chemical reaction between 0.5% NaOCl and by product ethyl alcohol in addition to intrinsic surfactant. This chemical reaction may alter impression surface energy [24, 30] increasing surface roughness lead to higher contact angle with stone mix , but still consider as wetting surface because mean value still below 90º [27, 25]. . The disinfection procedure can alter the surface properties of hydrophilize silicone elastomeric impression materail, rendering them more or less wettable by gypsum mix [26, 29]. This phenomenon due to different manufactures use different surfactants (not revealed by manufacturer) will react differently with different disinfectant solutions available.

The differences in wettability between putty and wash type may be related to difference in surfactant concentration in relation to other constituents of material tested. Especially putty type contain higher percentage of reinforcing agent to be stiffer than wash type [27].

While ,if impression is stored in humid environment after disinfection for two hr. affect significantly the wettability of putty type (A1with C1) (B1 with C1) and both types together (A3 with C3)(B3 with C3) p<0.001 Table 3. But not affect wash type alone (A2, B2, C2) p> 0.05. Storage for two hr. probably affects concentration of surfactant at surface leading to these variable results.

The practical out come from this work, is area of impression with high

requirement for detail reproduction should include putty and wash type to obtain better wettability of stone mix over the impression surface that will result in bubble free cast with details. Disinfection procedures not affect wettability of hydrophilized condensation silicon (putty +wash) also for wash type alone. Delay pouring of impression for two hours for any reason decrease wettability of impression.

Using both types together putty and wash type for impression making, not only decrease permanent deformation [27] , but also increase wettability of impression surface even after disinfection as concluded in the present study.

Further study should be done to measure wettability of hydrophilized condensation silicon (putty + wash) after disinfection with storage time less than two hr.

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Table (1) :Sample grouping

Group	**Description**
Group A	Control group: without disinfection
GroupA1	Putty type c-silicon 8 samples
GroupA2	Wash type c-silicon 8 samples
GroupA3	Putty+wash type c-silicon 8 samples
Group B	Experimental group: disinfection by immersion in 0.5% NaOCl for 10 mint.
GroupB1	Putty type c-silicon 8 samples
GroupB2	Wash type c-silicon 8 samples
GroupB3	Putty +wash type c-silicon 8 samples
Group C	Experimental group : storage for two hr. after disinfection by immersion in 0.5% NaOCl for 10 mint.
GroupC1	Putty type c-silicon 8 samples
GroupC2	Wash type c-silicon 8 samples
GroupC3	Putty +wash type c-silicon 8 samples

Table 2- Descriptive statistics of results of stone mix contact angle measurements with impression surface

Groups	N	Mean	Standard devations
A1	8	34.75	3.991
A2	8	32.88	7.318
A3	8	21.25	3.536
B1	8	22.63	3.378
B2	8	26	3.928
B3	8	18.38	2.134
C1	8	32.75	4.097
C2	8	28.38	3.204
C3	8	28.75	3.991

Table 3: Students t-Test

Paired groups		t	C.S*	P-Value
	A1 - B1	6.568	P<0.001	.000
	A1 - C1	3.191	P<0.01	.015
	B1 - C1	-4.784-	P<0.001	.002
	A2 - B2	2.089	P>0.05	.075
	A2 - C2	1.512	P>0.05	.174
	B2 - C2	-1.227-	P>0.05	.260
	A3 - B3	2.142	P>0.05	.069
	A3 - C3	-3.784-	P<0.001	.007
	B3 - C3	-7.213-	P<0.001	.000

- Coefficient of significance

A **B** **C**

Fig (1 A, measuring 2ml of mixed stone, B, dispensing 2ml of mixed stone over impression surface, C using vibrator)

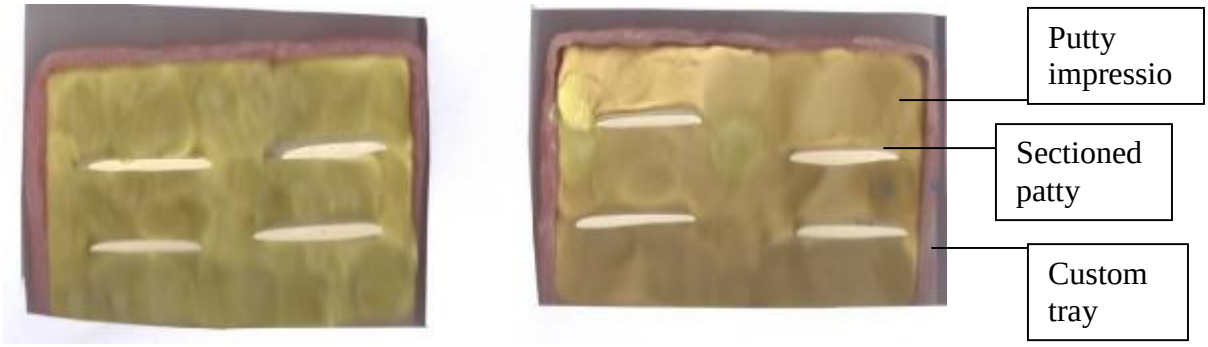
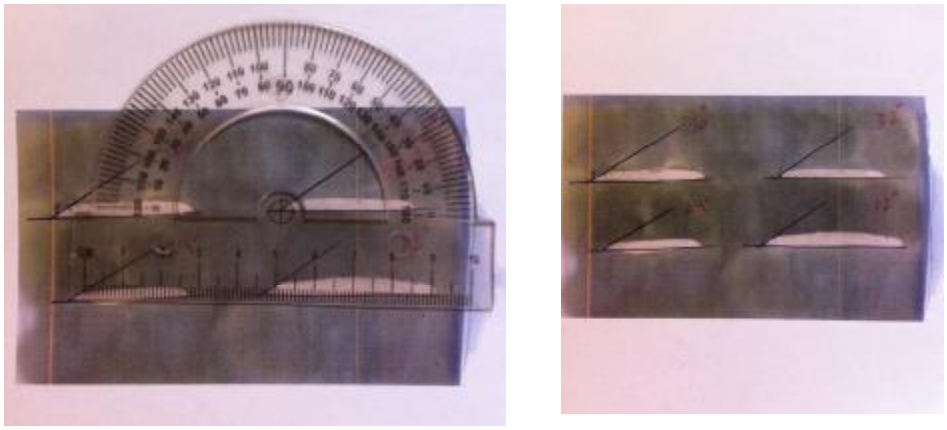


Fig. (2) Scanned Images of sectioned stone patties



A B

Fig (3 A, B protractor used to measure contact angle on printed scanned image of sectioned stone patties)

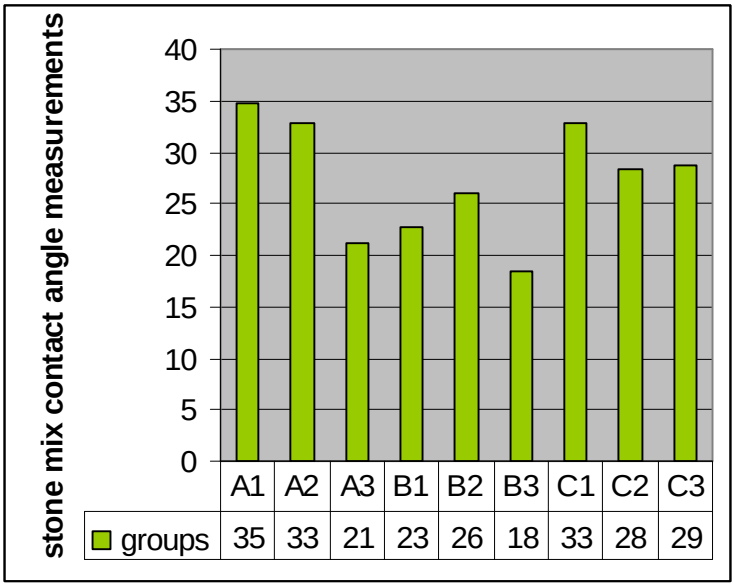


Fig 4. Bar chart showing results of the study