Effects of Chemical Disinfections on Dimensional Stability of Irreversible Hydrocolloid Impression

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Abstract **- This study was carried out to determine the linear dimensional stability of irreversible hydrocolloid impression materials on resulting dental stone casts after being immersed in two market available chemical disinfectants. Thirty impression samples for each of the two different alginates were taken from a maxillary acrylic model and then immersed in 1% alkylbenzyldimethylammonium chloride (ADBAC) for 3 minutes and 0.5% NaOCl for 10 minutes respectively. Selected measurements were made on the stone casts retrieved from each impression materials. The measurements were analyzed by using independent t test; for comparison among groups. Level of significance was set at $p<0.05$. Linear dimensions of all tested alginate impressions had changed after immersion in each chemical disinfectant. But these changes were clinically acceptable even for the least stable in dimension (maximum deviation 0.39 mm). Therefore, 1% alkylbenzyldimethylammonium chloride (ADBAC) should be considered as chemical disinfectant of choice for immersion disinfection of irreversible hydrocolloid impression material like the recommended chemical disinfectant, 0.5% sodium hypochlorite.**

Keywords; Chemical Disinfections, linear dimensional stability, alginate impression material, sodium hypochlorite, alkylbenzyldimethylammonium chloride

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Introduction

Awareness of the potential for spread of microorganisms and disease in the dental treatment has increased significantly and, resulted in a continuing effort to identify and eliminate possible routes for transmission and cross-contamination of diseases such as Hepatitis B, Tuberculosis, Herpes, and Acquired Immunodeficiency Syndrome (AIDS).

The procedure, impression taking is the essential in dentistry, not only for constructing study models in orthodontics and prosthetics dentistry but also for fabricating either fixed and removable prosthesis or implants prosthetics dentistry. During this procedure, impression materials may come into contact with oral tissues, saliva, and/or blood and it is generally assumed that once an impression is made, oral microbes are retained on the impression surfaces and persist thereon during the succeeding period (Samaranayake & Jennings, 1991).

In 1983, Leung and Schonfeld pointed out the recovery of microorganisms from the stone cast that retrieved from contaminated impression which shows that dental casts may also be a medium of cross-contamination between patients and dental personnel.

Among various impression materials, alginate, irreversible hydrocolloid materials tend to possess a higher intrinsic retentive potential for microbes during impression making. Its potential of retention of bacteria is two to five times greater compared with that of other elastomeric impression materials. This is

because of its organic in part, and hydrophilic and porous in nature. Alginate impressions are widely used to form study casts used to plan treatment, monitor changes, and fabricate provisional restorations and removable dental prostheses (Powers, 2011).

Recommendations and guidelines advocated the use of disinfecting solution, but there is still no universally recognized disinfection protocol for all impression materials (Blair & Wassell, 1996).

The researchers emphasized the infection control protocol to fulfill the dual purpose in that the disinfectant must be an effective antimicrobial agent while the dimensional stability and surface texture features of the impression material and resultant gypsum cast are being caused no adverse response because these physical properties are necessary for a true copy of the molded anatomical structures in order to provide a well-fitting and functional finished appliance.

Three methods of cold disinfection of impression materials exist; soaking, spraying, mixing with, or a substitute for, water used to mix alginate (Ahmad *et al*., 2007). Of the various methods of disinfectant agent application, immersion is considered to be the most reliable (ADA Council on Scientific Affairs and ADA Council on Dental Practice, 1996) because spraying tends to pool and thus all impression surfaces may not be adequately covered.

Chemical disinfectants for impression materials can be broadly classified into three categories (Monlinary & Runnells, 1991), high-level disinfectants namely, ethylene oxide gas or glutaraldehyde solutions which are able to inactivate spores and all other microbial forms (Matyas *et al*., 1990), intermediate level disinfectants namely, formaldehyde, chlorine compounds (e.g., sodium hypochlorite), iodophors and quaternary ammonium compounds, which may not inactivate spores but will destroy other microbes, in particular tubercle bacilli (Matyas *et al*., 1990), and low level disinfectants namely alcohols phenolic compounds, simple phenols, detergents which are unacceptable for disinfection of contaminated impressions (Monlinary & Runnells, 1991).

Alkylbenzyldimethylammonium chloride (ADBAC) is one of the quaternary ammonium compounds which have biocidal action derived from its alkaline rings. In this study, we applied the manufacturer's recommended concentration (1%) and exposure time (3 minutes) of it as reported in infection control recommendations for the dental office and the dental laboratory, "Since the compatibility of an impression material with a disinfectant varies, manufacturers' recommendations for proper disinfection should be followed" (ADA council on scientific affairs and ADA council on dental practice, 1996).

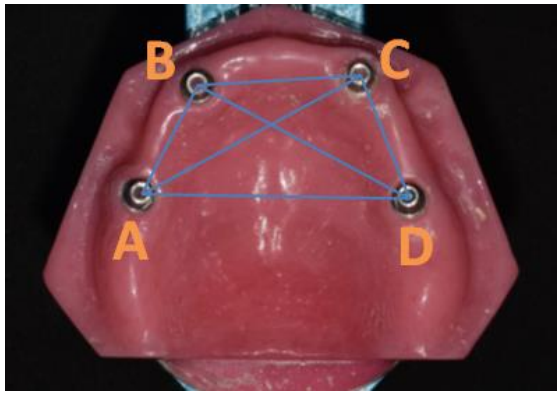
If sodium hypochlorite is used as a disinfectant, the American Dental Association (1991) recommends immersion disinfection for 10 minutes in concentration of 1:10 dilution (0.525%). Wala *et al*. (2009) and Ko-Ko (2010) also confirmed the efficacy of immersion in 0.5% sodium hypochlorite solution on oral microflora.

In this study dimensional stability of available two selected alginate products on dental stone casts are being used to analyze after disinfection by immersion in 1% alkylbenzyldimethylammonium chloride (Impresafe) for 3 minutes and 0.5% NaOCl for 10 minutes respectively.

Materials and Methods

In this *in vitro* comparative study, the

procedure for impression taking was performed by using acrylic master model of upper maxillary arch set up on plane line articulator on which four dummy implant prosthetics abutments are engaged at premolars and molar regions. The distance between premolar abutments is 25.53 mm, the distance between molar abutments is 41.85 mm and the distances between premolar and molar abutments at right side is 19.34 mm and at left side is 20.4 mm (Figure 1 and 2).



AB=19.34 mm	CD=20.4 mm
AC=39.17 mm	BD=37.33 mm
AD=41.85 mm	BC=25.53 mm

Figure 1. Master maxillary acrylic model with implant prosthetic abutments

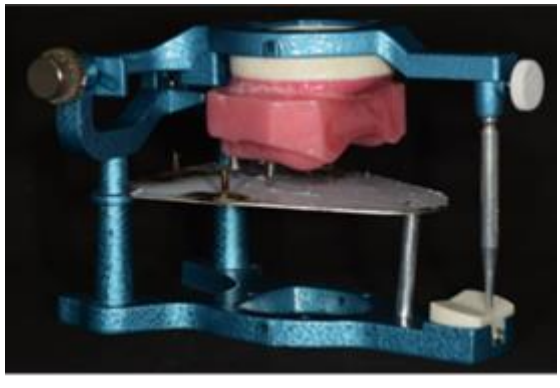


Figure 2. Master maxillary acrylic model set up on mean valued articulator

The impression of acrylic master model is made by using machined mixed alginate with correct water-powder ratio recommended by manufactures. Thirty impression samples for each of two different alginates were taken from a maxillary acrylic model and then immersed in 1% alkylbenzyldimethyl-ammonium chloride (Impresafe) for 3 minutes and 0.5% NaOCl for 10 minutes respectively.

The measurements for linear dimensional stability were carried out by digital slide caliper in six distances (2 antero-posteriors, 2 cross-arches (trans-verse) and 2 cross-arches (diagonals) on resultant dental stone casts. The measurements were analyzed by independent *t* test for comparison between groups. Level of significance was set at $p<0.05$. This study was approved by Research and Ethical Committee of University of Dental Medicine, Yangon.

Results

Linear dimensions of all tested alginate impressions had changed after immersion in both chemical disinfectants. In comparison of mean difference from master model, there were no statistically significant different between majority of study measurements on stone casts retrieved from alginate 1 and 2 impressions disinfected with two studied chemical disinfectants (Table 1 and 2).

Table 1. Comparison of mean difference from master model of study measurements on stone casts retrieved from alginate 1 impressions disinfected with two studied chemical disinfectants (n=60)

	Mean difference from master model(SD) (mm)		Mean difference (95%CI)	*t* statistic (df)	*p*-value*
	Impresafe	Sodium hypochlorite			
AB	0.07 (0.08)	0.26 (0.18)	-0.19 (-0.3, -0.1)	-3.96 (19.16)	0.001
CD	0.33 (0.13)	0.11 (0.10)	0.23 (0.14, 0.31)	5.47 (28)	0.000
AC	0.31 (0.44)	0.30 (0.20)	0.01 (-0.25, 0.27)	0.09 (19.77)	0.93
BD	0.39 (0.30)	0.31 (0.20)	0.09 (-0.11, 0.28)	0.92 (24.31)	0.37
AD	0.11 (0.13)	0.15 (0.11)	-0.04 (-0.13, 0.05)	-0.93 (28)	0.36
BC	0.16 (0.10)	0.11 (0.14)	0.05 (-0.03, 0.14)	1.24 (28)	0.23

*Independent *t* test

Table 2. Comparison of mean difference from master model of study measurements on stone casts retrieved from alginate 2 impressions disinfected with two chemical disinfectants (n=60)

	Mean difference from master model(SD) (mm)		Mean difference (95%CI)	*t* statistic (df)	*p*-value*
	Impresafe	Sodium hypochlorite			
AB	0.02 (0.03)	0.09 (0.05)	-0.02 (-0.10, -0.04)	-4.54 (28)	0.000
CD	0.10 (0.05)	0.15 (0.14)	-0.05 (-0.13, 0.03)	-1.30 (17.14)	0.21
AC	0.02 (0.15)	0.12 (0.18)	-0.10 (-0.22, 0.03)	-1.58 (28)	0.13
BD	0.20 (0.19)	0.28 (0.47)	-0.08 (-0.35, 0.19)	-0.61 (28)	0.55
AD	0.12 (0.17)	0.11 (0.09)	0.01 (-0.09, 0.12)	0.29 (20.82)	0.77
BC	0.03 (0.07)	0.003 (0.21)	0.03 (-0.09, 0.15)	0.48 (17.31)	0.64

*Independent *t* test

Table 3. Mean deviation (mm) of study distances from master model on stone casts retrieved from alginate 1 impressions disinfected by two studied disinfectants (n=60)

	AB	CD	AC	BD	AD	BC
Impresafe	0.07	0.33	0.31	0.39	0.11	0.16
Sodium hypochlorite	0.26	0.11	0.30	0.31	0.15	0.11

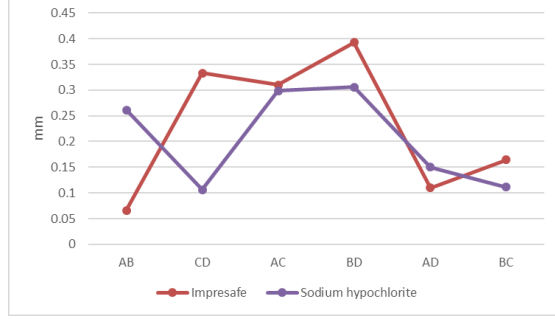


Figure 3. Mean deviation (mm) of study distances from master model on stone casts retrieved from alginate 1 impressions disinfected by two studied disinfectants (n=60)

The distance BD of casts fabricated from impressions of alginate 1 disinfected by immersion in 2% glutaraldehyde has the highest mean deviation value among the other distances (0.39 mm) (Table 3, Figure 3).

Table 4. Mean deviation (mm) of study distances from master model on stone casts retrieved from alginate 2 impressions disinfected by two studied disinfectants (n=60)

	AB	CD	AC	BD	AD	BC
Impresafe	0.02	0.10	0.02	0.2	0.12	0.03
Sodium hypochlorite	0.09	0.15	0.12	0.28	0.11	0.003

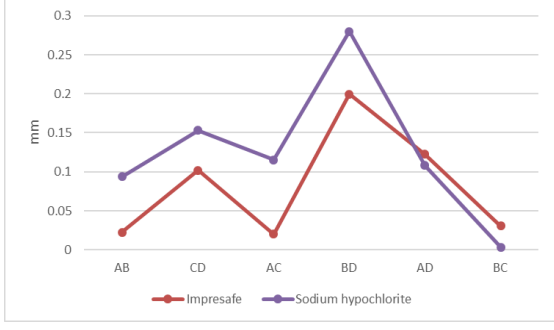


Figure 4. Mean deviation (mm) of study distances from master model on stone retrieved from alginate 2 impressions disinfected by two studied disinfectants (n=60)

The distance BC of casts fabricated from impressions of alginate 2 disinfected by immersion in 0.5% sodium hypochlorite has the lowest mean deviation value among the other distances (0.003 mm) (Table 4, Figure 4).

Discussion

In this study, compared with the acrylic master model, casts made from two different irreversible hydrocolloid impressions disinfected by immersion in two different chemical disinfectants were found to be maintained linear dimensional stability in both the anteroposterior and cross arch dimensions. Dimensional change in all specimens was found to be a change of less than 0.33 mm (mean deviation) in the anteroposterior dimension and 0.39 mm (mean deviation) in the cross arch (width) dimension when compared with the acrylic master model.

Hellie *et al*., (1985) demonstrated that posterior teeth are displaced 0.84 mm on the average with wedging and thus are capable of significant movement physiologically (Hellie *et al*., 1985). Gates and Nicholls (1981) has shown that distortion occurring after a mandibular opening greater than 20 mm ranges from 0 to 0.5 mm. Protrusive movements also cause the mandible to decrease in arch width from 0.1 to 0.5 mm (Gates & Nicholls, 1981). The distortion of casts made on disinfected impressions, is smaller than physiologic tooth movement and distortion of the mandible during mouth opening in impression procedure. This suggests that clinically, the distortion due to disinfection is negligible and irreversible hydrocolloid impressions can be safely disinfected by immersion with any of the disinfectants used in this study.

According to Taylor *et al*., (2002), the improvement in linear dimensional stability may be due to initial syneresis (causing contraction of impression material) counteracted by imbibition during disinfection and/or linear expansion of the setting gypsum material counter-acting imbibition, thus creating a more accurate cast. The results of this *in vitro* study can be considered to be an agreement of this theory.

Moreover, the least dimensional stability of specimen (0.39 mm) was observed in cast retrieved from alginate 1 (color-changed) and the most stable linear dimension of specimen (0.003 mm) was presented by cast retrieved from alginate 2 (no color-changed).

The observations of this study are

parallel with that of Buchan and Peggie, (1966). The decrease in pH was more marked with the color-changed alginate than with the others (Bhushan, 1999). Bayindir *et al.,* (2002) also stated that hydrocolloids with a high pH showed better dimensional stability than those with a low pH.

Conclusion

1% alkylbenzyldimethylammonium chloride (ADBAC) should be considered as chemical disinfectant of choice for immersion disinfection of irreversible hydrocolloid impression material like the recommended chemical disinfectant, 0.5% sodium hypochlorite.

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The authors declare there is no potential conflict of interest.

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