

Study on linear dimensional stability and surface detail reproducibility of irreversible hydrocolloid impression materials on dental stone casts after immersion in disinfectants

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Abstract

This study was carried to determine the linear dimensional stability and surface detail reproducibility of irreversible hydrocolloid impression materials on resulting dental stone casts after immersion in the intermediate and high-level chemical disinfectants. 69 impression samples for each of two different alginates were taken from ruled stainless steel test block and then immersed in 2% glutaraldehyde, 0.5% NaOCl and distilled water for 10 min. Selected measurements were made on the stone casts made from each impression materials. The measurements were analyzed by one way ANOVA, followed by Post Hoc test; Tukey for comparison within groups. Level of significance was set at $p < 0.05$. Linear dimensions of all tested alginate impressions had changed after immersion in each chemical disinfectants and distilled water (control). But these changes were clinically acceptable even for least stable in dimension (maximum deviation 0.24%/0.07mm). Similarly, there was no clinical significance in term of surface detail reproduction though

statistically significant were observed between study groups. Therefore, 2% glutaraldehyde 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.

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 AIDS.

The procedure, impression taking is the essential in dentistry, not only for constructing of study models in orthodontics and prosthetics dentistry but also for fabricating either fixed and removal 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 ensuing period [1].

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. Moreover, alginate impressions are widely used to form study casts used to plan treatment, monitor changes, and fabricate provisional restorations and removable dental prostheses [2].

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 [3].

Recommendations and guidelines advocated the use of a disinfecting solution, but there is still no universally recognized disinfection protocol for all impression materials [4].

The researchers emphasized the infection control protocol to fulfill the dual purpose, in that 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 [5]. Of the various methods of disinfectant agent application, immersion is considered to be the most reliable [6] 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 [7]; high-level disinfectants namely, ethylene oxide gas or glutaraldehyde solutions which are able to inactivate spores and all other microbial forms (8); intermediate level disinfectants namely, formaldehyde, chlorine compounds (e.g., sodium hypochlorite), iodophors and alcohols phenolic compounds which may not inactivate spores but will destroy other microbes, in particular tubercle bacilli [8]; and low level disinfectants namely, quaternary ammonium compounds, simple phenols, detergents which are unacceptable for disinfection of contaminated impressions [7].

Efficient disinfection has achieved by immersion of impressions in 2% glutaraldehyde for just 10 minutes [9]. Johnson, (1998) stated that the reproduction of surface detail of the elastomeric impression was unaffected by disinfection with the glyoxal and phenol glutaraldehyde and disinfection with these same disinfectants of irreversible hydrocolloid impression produced a surface smoother than the controls [10]. However, Roger and James, (1987) indicated that the polyether was affected dimensionally by immersing in a 2% glutaraldehyde solution (shrank when dry and swelled when in solution)[11].

If sodium hypochlorite is used as a disinfectant, the American Dental Association (1994) recommended immersion disinfection for 10 minutes in concentration of 1:10 dilution

(0.525%) [12]. Wala, et al.,(2009) and Ko, (2010) also confirmed the efficacy of immersion in 0.5% sodium hypochlorite solution on oral microflora [13, 14].

In this experimental study dimensional accuracy and surface detail reproducibility of available selected alginate products on dental stone casts are being used to analyze after disinfection by immersion in 2% glutaraldehyde and 0.5% NaOCl for 10 minutes.

Materials and methods

In this in-vitro comparative study, the procedure for impression taking of ruled test block and pouring of dental stone cast were performed in accordance with ISO 1563:1996 (Compatibility with gypsum and reproduction of detail of dental alginate impression material). The surface of test block has 4 reference points which represent for canines and first molars and 3 reference lines (20, 50 and 75 µm in width and 25 mm in length) (figure1).



Figure 1. Ruled test block

138 impressions were taken from a test block by using two different alginate impression materials and then were immersed in 2% glutaraldehyde, 0.5% NaOCl and distilled water for 10 min (table 1).

Table 1. Study groups of impression samples

Group	Product name	Chemical disinfectant
Group GA-1 (n = 23)	Alginate-1	2% glutaraldehyde
Group Na-1 (n = 23)	Alginate-1	0.5% NaOCl
Control DW-1 (n=23)	Alginate-1	Distilled Water
Control DW-2 (n=23)	Alginate-2	Distilled Water
Group Na-2 (n = 23)	Alginate-2	0.5% NaOCl
Group GA-2 (n = 23)	Alginate-2	2% glutaraldehyde

The measurements for linear dimensional stability were carried out by digital slide caliper in six distances (2 antero-posteriors, 2 cross-arches (transverse) and 2 cross-arches (diagonals))on resultant dental stone casts (figure 2).

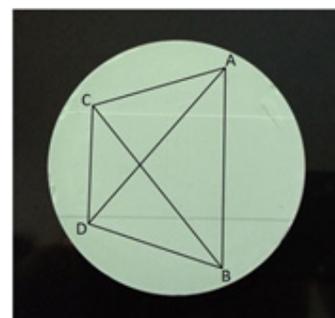


Figure 2. Resultant dental stone cast showing linear dimensional measurements

Surface detail reproduction was evaluated by examining 50 µm wide reference line of 25 mm length on the stone casts under USB microscope at 50x magnification and graded using a scoring system from score 1 to score 4. (C. P. OWEN, 1986) (figure 3)

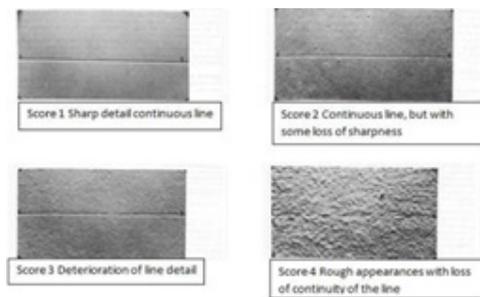


Figure 3. Scores for surface detail reproducibility

The measurements were analyzed by one way ANOVA, followed by Post Hoc test; Tukey for comparison within groups. Level of significance was set at $p < 0.05$.

Results

The mean surface detail reproducibility score values for alginate 2 are statistically different between control group and 0.5% NaOCl group and between 2% glutaraldehyde group and 0.5% NaOCl group. However, there are no significant mean score values difference between control group and 2% glutaraldehyde group (table 2, figure 4).

The mean surface detail reproducibility score values for alginate 1 are not statistically different among study groups.

Table 2. Comparison of mean surface detail reproducibility score among different study groups for alginate 2

Groups	Mean (SD)	F statistics (df)	p value*
Control	1.2609 (0.4489)	13.910 (2,66)	<0.05
2% glutaraldehyde	1.2609 (0.4489)		
0.5% NaOCl	1.8696 (0.5308)		

*One – way ANOVA

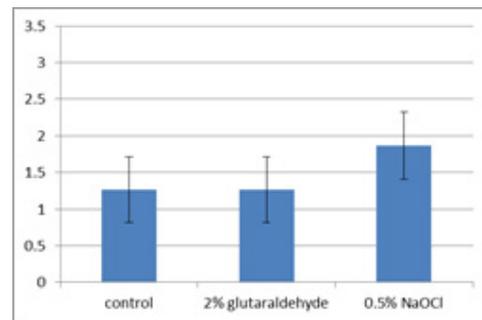


Figure 4. Comparison of mean surface detail reproducibility score among different study groups for alginate 2

Similarly, Linear dimensions of all tested alginate impressions had changed after immersion in either chemical disinfectants or distilled water (control).

Table 3. Mean deviation percentage of 6 distances of different study groups for alginate 1

	AB	CD	AC	BD	AD	BC
Control	-0.07991	-0.04847	0.067193	0.158269	-0.0261	0.098972
2% glutaraldehyde	-0.03799	-0.08646	0.160367	-0.23588	0.07113	0.062509
0.5% NaOCl	-0.00262	-0.08253	0.123635	0.124789	0.08074	0.076399

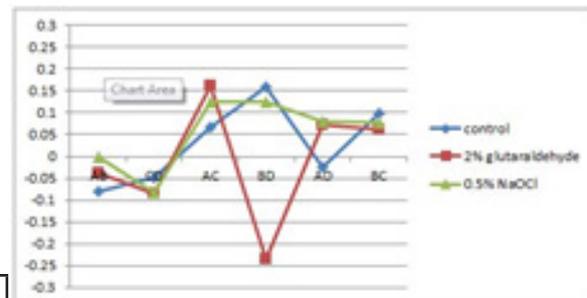


Figure 5. Mean deviation percentage of 6 distances of different study groups for alginate 1

Table 4. Mean deviation percentage of 6 distances of different study groups for alginate 2

	AB	CD	AC	BD	AD	BC
Control	-0.1100	-0.0485	0.150512	0.085222	0.015627	0.040804
2% glutaraldehyde	-0.1729	-0.1507	0.047483	0.114136	-0.01389	0.015627
0.5% NaOCl	0.08253	-0.1035	0.095862	0.027393	0.078136	-0.00868

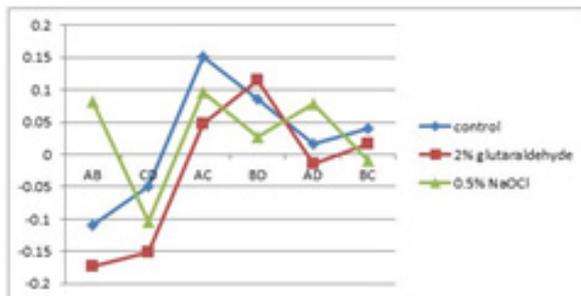


Figure 6. Mean deviation percentage of 6 distances of different study groups for alginate 2

The distance BD of casts fabricated from impressions of alginate 1 disinfected by immersion in 2% glutaraldehyde gets the highest mean deviation percentage value among the other distances (0.24%) (Table 3, figure 5).

The distance AB of casts fabricated from impressions of alginate 2 disinfected by immersion in 2% glutaraldehyde gets the highest mean deviation percentage value among the other distances (0.17%) (table 4, figure 6).

Discussion

In this study, compared with the test block, casts made from two different irreversible hydrocolloid impressions disinfected by immersion in two different chemical disinfectants were found to maintain linear dimensional stability in both the anteroposterior and cross arch dimensions. Dimensional change was found to be less than 0.24% (mean deviation percentage) of test block in all specimens, which represents a change of less than 0.06 mm (60 μ m) in the anteroposterior and 0.07 mm (70 μ m) in the cross arch (width) dimension when compared with the test block.

Hellie, et al., 1985 demonstrated that posterior teeth are displaced 84 μ m on the average with wedging, thus are capable of significant movement physiologically [15].

Gates & Nicholls, (1981) has shown that distortion occurring after a mandibular opening greater than 20 mm ranges from 0 to 0.3 mm. Protrusive movements also cause the mandible to decrease in arch width from 0.1 to 0.5 mm [16]. 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 counteracting imbibition, thus creating a more accurate cast [17]. The results of this vitro study can be considered to be an agreement of this theory.

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 [18]. Bayindir, Yanikoglu and Duymus (2002), also stated that hydrocolloids with a high pH showed better dimensional stability than those with a low pH [19].

Casts made from alginate 2 (color change/fast set) was shown to be of poor surface detail reproducibility following immersion in 0.5% sodium hypochlorite. This deterioration in surface detail reproducibility of impression materials following immersion in sodium hypochlorite has been reported previously [20].

Conversely, casts made from Cavex

(normal set) immersed in 2% glutaraldehyde and 0.5% sodium hypochlorite and those made from Cavex (Color change/fast set) immersed in 2% glutaraldehyde showed no loss in surface detail reproducibility. Preliminary studies of Taylor, et al., (2002) showed that the extent of absorption of a disinfectant into impression materials varied with brands. Irreversible hydrocolloid impression materials which showed the least penetration of disinfectant may explain the superior surface detail reproduction [17].

Conclusion

2% glutaraldehyde 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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