

A 12.5% Virgin Coconut Oil Solution as an Alginate Impression Material Disinfectant

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Abstract

To prevent cross-infection, alginate dental impression molds need to be disinfected by immersion. Furthermore, 12.5% virgin coconut oil (VCO) has been shown to be an effective oral antimicrobial agent. However, alginate impression material exhibits both imbibition and syneresis, so the immersion can affect the size and shape of the impression. Immersion in 1% sodium hypochlorite or 2% glutaraldehyde solutions increase dimensions by 0.1-0.2%. The purpose of this study was to determine the effect of immersion in 12.5% VCO on the dimensions of alginate dental impressions. Seventy alginate impressions were marked at three points with a tripod device and either immersed in 12.5% VCO for 5 min or incubated in air for 5 minutes. The distances between the marked points were then measured using calipers. There was a significant increase in the distances between the points in the VCO group compared with the control ($p < 0.001$). While 12.5% VCO treatment results in an increase in alginate impression size, the increase is comparable to that produced by sodium hypochlorite and glutaraldehyde solutions and within the acceptable limits provided by the American National Standards Institute/American Dental Association's (ANSI/ADA) specification no.18.

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Introduction

Taking dental impression in dental practice is a routine procedure for various dental treatments and is an integral part of dentistry practice.¹ For example it is important to do the initial impression before we start the dental treatment in order to observe and defining a treatment plan.

Different types of impression materials are used to produce impressions with the desired accuracy. Alginate is one of the most commonly used materials for the production of dental impressions and taking an impression with alginate is simple and cost-effective. The hydrophilic nature of alginate facilitates the production of an accurate impression in the presence of oral saliva or blood.² Alginates are often used for initial impressions and impressions for indirect temporary crowns and bridges, study

and antagonizing dental models, orthodontic models, mouth-shaping for sports, individual scoop manufacturing for bleaching care and removable denture fabrication and many more. A study has shown that alginate impressions can also be used as final impressions for fixed indirect restorations with chamfer-shaped margin preparations.³

As per the requirements of the American Dental Association (ADA), cross-infection protocols require that dental impressions are disinfected before being sent to the laboratory.⁴⁻⁷ Attention must be paid to the handling and disinfection of a patient's dental impression when he is visiting a dental laboratory because the final molded teeth should not be contaminated with pathogenic microorganisms from the patient's saliva, bacterial plaque, and blood as this could present a significant cross-infection risk for harmful microorganisms such as human immunodeficiency and hepatitis-B viruses.

The accuracy of taking impressions with alginate should also be considered, and this is greatly influenced by the time it takes for the impression to set. In addition, the disinfectant solution used also affects the accuracy of the impression. After setting and removal from the mouth, the impression should be washed with a

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spray of water and then disinfected with a solution such as 1% sodium hypochlorite solution or 2% glutaraldehyde, where. At this point, distortion can be problematic if proper procedures are not followed, since alginate is naturally hydrophilic and could expand if takes up additional water or liquid disinfectant.⁸ This can result in dimensional changes of up to 0.1%, resulting in a change to the quality of the mold surface; this will affect the dimensions of the foundry's model and ultimately the success of the final restoration.

In addition to causing these shape changes, existing disinfecting solutions such as 1% sodium hypochlorite and 2% glutaraldehyde are also potentially hazardous,⁹ so there is a need for more environmentally friendly disinfecting solutions that can reduce the number of microorganisms, bacteria and fungi while not significantly affect the shape of the impressions. Currently, many herb-derived ingredients are starting to be used as antiseptics for safety reasons. Once such ingredient is *Cocos nucifera* or "virgin coconut" oil (VCO). VCO is a natural antimicrobial, antibacterial, antiviral, antifungal and antiprotozoal, because its saturated fatty acids resemble the those in the membranes of viruses and bacterial and because their small size make it easy for them to enter the membranes and destroy the microorganisms, including Gram-positive and Gram-negative bacteria.²

Previous research has shown that using a mouthwash containing 12.5% VCO for 30 seconds reduced inflammation problem associated with dental bridges and artificial crowns.³ Therefore, 12.5% VCO might also be useful as a simple, safe, cost-effective and environmentally friendly disinfecting solution for alginate molds.

As mentioned above, alginate is hydrophilic, to it is important when evaluating a new antimicrobial agent, such as VCO, to assess any changes it may make to the dimensions of the impression so that the quality of the final restoration is not affected. The aim of this study, therefore, was to assess the changes to the size and shape of alginate impressions after soaking in a solution of VCO.

Materials and methods

This study was approved by the Ethical

Committee of the Faculty of Dentistry, Universitas Indonesia (No: 19 / *Ethical Approval* / FKGUI/IV/2017). This was an observational and cross-sectional study conducted at Faculty of Dentistry, Universitas Indonesia. Subjects were recruited from patients who came to the RSGM FKG-UI clinic and all provided signed, informed consent. Inclusion criteria were the ability to communicate and receive instructions during the impression process, low vomiting reflexes to enable the impression process to run smoothly and a toothless upper jaw to facilitate measurement of the dental impressions with digital calipers (Figure 3).



Figure 3. Digital caliper with a precision of 0.01 mm.

Study design

The study consisted of 2 groups of 70 samples, with each impression being produced with Aroma Fine Plus Dental Impression alginate from GC Corporation, Tokyo, Japan. The alginate was produced using 1 tsp powder and 20 ml water, which was stirred for 30 seconds and the oral setting time was 120 seconds.

A custom-made tripod consisting of three metal pins, A, B, and C (Figure 1) was used to mark the impressions made in this study. The distance between pins A and C was 45.76 mm, between pins B and C was 45.29 mm and between pins A pin B was 43.82 mm. These values represent the mean of 3 measurements.

Impressions were taken from the patients using alginate impression material, and the impressions rinsed under flowing water for 10 seconds prior to marking with the tripod (Figure 2). Impressions in the control group were then left to stand in air for 5 minutes before measuring the distances between the points, while those in the treatment group were soaked in 12.5% VCO solution for 5 minutes prior to measurement.

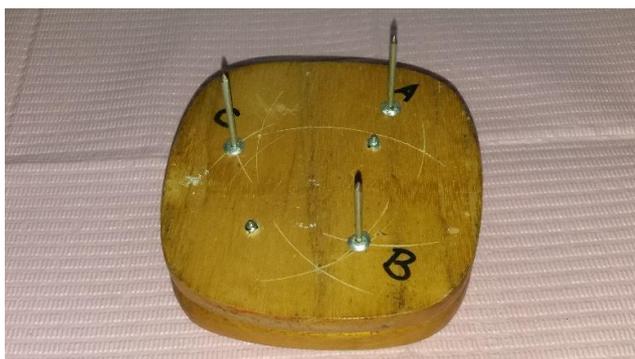


Figure 1. Tripod with three pins, A, B and C



Figure 2. Impression after marking with the tripod. mm and the length between pin A with pin B is 43.82 mm.

Measurement

Twelve samples were measured using a digital caliper with a precision of 0.01 mm. Measurements were made 3 times between the points marked by the tripod. Point A was a point located in the anterior region of the model, or the upper region in Figure 2, point B was in the right posterior region, or the right lower region of Figure 2, and point C was in the left posterior region, or the lower left region of Figure 2.

The vertical dimension was assessed by measuring the distance between points A and B, and between A and C, while the horizontal dimension was assessed by measuring the distance between points B and C. The initial distance between A and C was 45.76 mm, between B and C was 45.29.

Data Analysis

Univariate analysis was used to test for normality in the specimen characteristics, and

bivariate analysis to test the relationship between two variables, followed by unpaired *t*-test.

Results

This study assessed whether there were any changes in the spacing between points on the impressions after letting alginate impressions stand for 5 min or after soaking in 12.5% VCO solution for 5 minutes.

Soaking in VCO increased the distances in all three directs (AB, AC and BC) relative to the control (unsoaked) group, and these differences were all statistically significant ($p < 0.001$; Table 1). Furthermore, distances in the control group were all smaller than in the tripod used to make the marks.

	With VCO	Without VCO	p-value ^a
	Average ± SD Min-Max	Average ± SD Min-Max	
AB	43.89 ± 0.15 (43.86–43.93)	43.82 ± 0.06 (43.80–43.83)	<0.001
ACAC	45.82 ± 0.17 (45.78–45.87)	45.74 ± 0.06 (45.72–45.75)	<0.001
BC	45.35 ± 0.16 (45.32–45.38)	45.27 ± 0.06 (45.25–45.28)	<0.001

Table 1. Univariate analysis of mean differences in AB, BC and AC distances (in mm) with or without soaking in VCO. ^a Mann–Whitney Test.

The mean ABC circumference also increased after VCO soaking ($p < 0.001$; Table 2). Additionally, there was a significant increase in the distances between the points in the VCO group compared with the control ($p < 0.001$). Compared to the tripod, soaking increased the ABC circumference from 134.89 mm to 135.07 mm while in the control group the circumference decrease from 134.89 mm to 134.82 mm.

The absolute and percentage changes of the three distances and the ABC perimeter between the initial tripod positions and in the VCO soaked impressions are shown in Table 3.

	Initial distance (mm)	After 12.5% VCO (mm)	Difference (mm)	Change (%)
AB	43.82	43.89	0.07	0.16
AC	45.76	45.82	0.06	0.13
BC	45.29	45.34	0.05	0.11
ABC circumference	134.89	135.07	0.18	0.13

Table 3. Percentage (%) changes AB, BC and AC distances.

With VCO	Without VCO	P-value ^a	Mean Difference	IK95%	
				Min	Max
135.07±0.03	134.82±0.01	< 0.001	0.25	0.24	0.26

Table 2. Mean ABC perimeters (in mm) of dental impressions with or without soaking in VCO. ^aUnpaired *t*-test.

Discussion

Good molds should have accurate and stable dimensions until they are filled with dental stone. Accuracy means the ability to reproduce the actual dental features, while stability means the ability to maintain accuracy over a period of time. The hydrophilic nature of alginate molds means that they are highly influenced by water and can expand due to absorption when placed in aqueous media or undergo shrinkage or syneresis due to evaporation if left to dehydrate.^{10,11,12}

Syneresis is most influenced by the sodium phosphate contained in the alginate material itself. Other factors that may change alginate mold dimensions include an improper plaster and powder ratio, movement during the gelation process or removal of alginate printing material from improper molding. In addition, the methods and types of disinfectant solutions used also influence mold shape.^{10,12}

Suitable disinfectant solutions for alginate molds are 1% sodium hypochlorite and 2% glutaraldehyde. However, both of these chemicals are potentially hazardous,¹⁹ so there is a need for more environmentally friendly antimicrobial agents that do not alter the shapes of dental impressions.¹³⁻¹⁵

Many herbal extracts have recently been tested for their antiseptic qualities because of their improved safety profiles, including VCO, which has antimicrobial, antibacterial, antiviral, antifungal and antiprotozoal activity.¹⁵

The use of 12.5% VCO in 20 subjects who used dental bridges and had gingivitis showed that there was a significant decrease in gingival index after gargling with 12.5% VCO for 30 s, indicating that VCO was able to counter inflammatory problems associated with dental bridges and crowns.¹⁴

This research was conducted to determine the dimensional changes that occur in alginate dental impressions after soaking in 12.5% VCO solution, since VCO could represent a simple, safe, cost-effective and environmentally friendly disinfecting solution for alginate molds.¹⁴

We found that 12.5% VCO treatment increase all measured dimensions by 0.11–0.16%. Furthermore, incubation of control molds in air resulted in shrinkage in all dimensions, and the difference between the control and VCO-treated impressions was statistically significant

for all measured parameters ($p < 0.001$).

Alginate dental impression material exhibits imbibition or syneresis which can influence its shape during disinfection by soaking.³ When imbibition occurs, the mold will expand and become larger than before, while during syneresis water evaporates and the mold shrinks.^{10,12} Immersion in 1% sodium hypochlorite or 2% glutaraldehyde for disinfections results in an irreversible expansion of the hydrocolloid by 0.1–0.2%.^{6,7}

In this study, immersion of alginate impressions in 12.5% VCO solution resulted in a 0.05 mm (0.1%) increase between the points measured. Khalid Mariya, et al. (2015) used the same methodology as the present study and found that an 0.2 mm was an acceptable distance change during sterilization (this study revealed changes 0.05 mm or about 0.1%). Additionally, the American National Standards Institute/American Dental Association's (ANSI/ADA) specification no.18 states that the dental impression material shall not exhibit a change of $> 0.5\%$ of the master die measured using calipers.^{16,17,12} Immersion of alginate molds in 12.5% VCO is therefore acceptable because the changes that occur are all smaller than 0.5% indicating that 12.5% VCO is suitable for the purpose of disinfection of such dental molds.

Conclusions

Soaking alginate dental impressions in 12.5% VCO results in dimensional changes of 0.05 mm or 0.1%. That is acceptable because the changes that occur are all smaller than 0.5% indicating that 12.5% VCO is suitable for the purpose of disinfection of such dental mold. Thus, sterilization by this method does not compromise the functionality of the dental impression.

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Declaration of Interest

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