

## Effect of Spraying Time of Sodium Hypochlorite Solution on the Dimensional Stability of Alginate

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### Abstract

Alginate is a medium for transmitting infection, so it needs to be disinfected. Alginate impression can be disinfected by spraying 5.25% sodium hypochlorite solution with a disinfection time of 5, 10 and 15 minutes. The disinfection process of alginate impression must not undergo dimensional changes. ADA states that impression materials must not experience a dimensional change of more than 0.5% from the initial size. The aim of this research was to determine the effect of different disinfection times of 5.25% sodium hypochlorite solution on changes in the dimensions of alginate.

This research was an experimental laboratory with a post test only control group design with 24 samples. The alginate impression was sprayed with distilled water solution as a control, 5.25% sodium hypochlorite solution was left for 5 minutes, 10 minutes and 15 minutes then filled with gypsum, then measured using a digital caliper. Data were analyzed using the One Way Anova test.

The results showed that the largest change in dimensional stability was in the group spraying 5.25% sodium hypochlorite solution for 15 minutes, while the smallest was in the 5 minute group. The One Way Anova test showed that there was a significant difference ( $p < 0.05$ ) between groups. In conclusion, the dimensional stability of the alginate impression was influenced by the disinfection time of the 5.25% sodium hypochlorite solution. The dimensional changes increase with the length of disinfection time.

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### Introduction

Impression materials in dentistry are used to obtain negative impressions of the oral cavity. The impressions will be used to obtain a study model or working model. The impression material that is often used is alginate.<sup>1</sup> Alginate has syneresis and imbibition properties. Syneresis is the loss of water content in alginate, which can cause shrinkage.<sup>2</sup> The imbibition property occurs when it comes into contact with water; the alginate will absorb water so that the impression will expand easily. These two properties can cause dimensional changes in the alginate impression.<sup>1</sup> According to American National Standards Institute/American Dental Association (ANSI/ADA) specification no. 18, the impression material must not experience a dimensional

change of more than 0.5%.<sup>3</sup>

The patient's dental impression procedure might spread infectious diseases like herpes, hepatitis, tuberculosis (TBC), acquired immune deficiency syndrome (AIDS), because blood and saliva adhere to the impression.<sup>4</sup> Patient saliva can also transmit the corona virus. The corona virus, also known as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), is the cause of the pandemic that has spread almost the entire world. This pandemic, named COVID-19, began in December 2019, in the city of Wuhan in China. On November 24<sup>th</sup> 2021, the World Health Organization (WHO) stated that this virus had infected 257 million people worldwide, including 4 million people in Indonesia.<sup>5</sup> Based on the Decree of the President of the Republic of Indonesia number 17 of 2023, Indonesia is declared to have moved from a pandemic period to endemic Covid-19.<sup>6</sup>

One effort to prevent cross infection is to disinfect the impression material.<sup>1</sup> The British Dental Association recommends disinfecting impression materials before sending them to the

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laboratory.<sup>2</sup> The ADA also recommends cleaning the impressions from blood, saliva, and adhering tissue after that, followed by disinfecting the impressions.<sup>7</sup>

The disinfection method recommended by the ADA and the Center of Disease and Prevention (CDC) for disinfection is the soaking and spraying method.<sup>2</sup> Previous research stated that spraying and soaking techniques were proven to have the same anti-microbial effectiveness.<sup>1,3</sup> Considerations that must be determined in choosing a disinfection method are the effect on dimensional stability, surface detail of the alginate mold and effectiveness in killing bacteria.<sup>8</sup>

The spraying method is considered a more effective method for reducing the occurrence of imbibition on impressions compared to the immersion method.<sup>4</sup> Previous research comparing spraying and immersion techniques found that the immersion disinfectant technique resulted in greater changes in dimensional stability compared to the spraying technique.<sup>1,8</sup>

Sodium hypochlorite (NaOCl) is an effective ADA recommended disinfectant solution for alginate impression materials.<sup>9</sup> NaOCl is a disinfectant solution that is often used because it is cheap and easy to obtain. NaOCl has been proven to be effective in killing various viruses such as hepatitis viruses, SARS, HIV, as well as gram-positive and gram-negative bacteria.<sup>10</sup> The concentration of NaOCl solution as a disinfectant solution recommended by the ADA is a concentration of 0.5%, 1%, 2%, 5%, 5.25%.<sup>11</sup>

Research conducted by Nurliyani et al., (2022) regarding the effect of the concentration of sodium hypochlorite solution 5%, 1%, 2%, 5%, 5.25%. The results of this research showed that the sodium hypochlorite solution experienced the least dimensional changes at a concentration of 5.25%.<sup>5</sup> Another study conducted by Hasana et al., (2014) regarding the effect of spraying disinfectant with 80% betel leaf solution on the dimensional stability of alginate molds with spray times of 5 minutes, 10 minutes and 15 minutes. The results of this research show that there is no significant difference in the dimensional stability of alginate when sprayed for 5 minutes, 10 minutes and 15 minutes.<sup>3</sup> Based on the description above, the aim of this research is to determine the effect of differences in disinfection

time of 5.25% sodium hypochlorite solution on changes in the dimensions of alginate molds.

## Materials and methods

This research was a laboratory experimental with a post test only control group design. The research was conducted in the Clinical Skills room at the Faculty of Dentistry, Andalas University. The study was approved by the Ethics Committee of Medicine Faculty of Andalas University with No. 592/UN.16.2/KEP-FK/2023.

The number of research samples was 24 samples with 6 treatment groups, namely 3 groups of alginate molds which were sprayed with distilled water and left for 5, 10 and 15 minutes. Then 3 groups of alginate molds were sprayed with 5.25% sodium hypochlorite solution for 5, 10 and 15 minutes.

The 10% sodium hypochlorite solution was diluted to a concentration of 5.25% using the dilution formula, namely  $M1V1=M2V2$ .<sup>8</sup> The alginate was manipulated according to the W/P ratio until the mixture was homogeneous and placed in the master cast. The master cast is in the form of a tube with a diameter of 28 mm and a height of 18 mm.<sup>9</sup> The alginate impression doused with running water for 10 seconds, then disinfection was carried out on the alginate.<sup>2</sup>

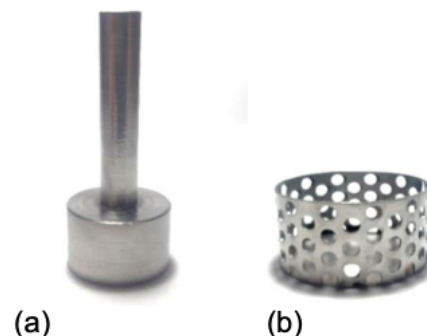


Figure 1. (a) master cast, (b) printing tool (tray).

## Results

Results of measuring the average change in dimensions of the gypsum model cast from an alginate mold that was sprayed with distilled water and 5.25% sodium hypochlorite solution which was left for 5, 10 and 15 minutes by calculating the difference from the measurement after treatment minus the measurement before treatment (master cast). The average change in

dimensions was used to find the change in dimensions in percentage form. The percentage change in dimensions was obtained using the dimensional change formula.<sup>2</sup>

$$\frac{\text{The mean change in dimensions}}{\text{Mean initial measurements (master cast)}} \times 100\%$$

The research results showed that the smallest dimensional change in the group sprayed with sodium hypochlorite solution for 5 minutes was 0.16%, and the largest in the group sprayed with distilled water for 15 minutes was 0.357%. Based on the results of dimensional changes, it can be seen that the longer the spraying time of 5.25% sodium hypochlorite solution, the greater the dimensional changes that occur in the alginate mold. All treatment groups experienced dimensional changes that were still within ADA standards, namely less than 0.5%.

The results of the normality test using Shapiro Wilk showed that the p value for each treatment was >0.05, which means the data was normally distributed. One Way Anova test was carried out to see the differences between alginate molds sprayed with distilled water solution, 5.25% sodium hypochlorite solution for 5 minutes, 10 minutes and 15 minutes which can be seen in table 1.

Group	n	Mean (Mpa)	Standard Deviation	p value
Aquades 5 minutes	4	28,070	0.008	0,000
Sodium Hypochlorite 5.25% 5 minutes	4	28,045	0.013	
Aquades 10 minutes	4	28,092	0.021	
Sodium Hypochlorite 5.25% 10 minutes	4	28,057	0.010	
Aquades 15 minutes	4	28,100	0.008	
Sodium Hypochlorite 5.25% 15 minutes	4	28,075	0.013	

**Table 1.** One Way Anova test results show differences between dimensional measures between treatment groups.

Based on table 1, the results of the One Way Anova test showed that there were significant differences (p<0.05) in the diameter measurements of the gypsum models produced by alginate molds for each treatment group. The highest average difference in the diameter of the gypsum model after spraying the alginate mold occurred in the distilled water group which was sprayed for 15 minutes with an average value of 28.1 mm. The smallest average difference in the

diameter of the gypsum model after spraying the alginate mold occurred in the 5.25% sodium hypochlorite solution group which was sprayed for 5 minutes with an average value of 28,045 mm. To determine the significance between one treatment group and another treatment group, continue with the Post Hoc Least Significant Difference (LSD) test.

Group Treatment	Sodium hypochlorite 5.25% 5 minutes	Aquades 10 minutes	Sodium hypochlorite 5.25% 10 minutes	Aquades 15 minutes	Sodium hypochlorite 5.25% 15 min
Aquades 5 minutes	0.013*	0.023*	0.184	0.004*	0.588
Sodium hypochlorite 5.25% 5 minutes		0,000*	0.184	0,000*	0.004*
Aquades 10 minutes			0.001*	0.418	0.069
Sodium hypochlorite 5.25% 10 minutes				0,000*	0.069
Aquades 15 minutes					0.013*

**Table 2.** Post Hoc Least Significant Difference (LSD) test results based on the concentration of sodium hypochlorite solution.

Based on table 2, the results of the Post Hoc LSD analysis can be concluded that there was a significant difference in dimensional stability (p<0.05) between 5 minute distilled water compared to the group of 5.25% sodium hypochlorite solution, 5 minute distilled water, 10 minute distilled water, and 15 distilled water. Likewise, sodium hypochlorite 5.25% 5 minutes compared to distilled water 10 minutes, distilled water 15 minutes and sodium hypochlorite 5.25% 15 minutes. Then between distilled water for 10 minutes compared to sodium hypochlorite 5.25% 10 minutes. Between sodium hypochlorite 5.25% 10 minutes with distilled water 15 minutes and between distilled water 15 minutes and sodium hypochlorite 5.25% 15 minutes. Differences in dimensional stability that were not significant (p>0.05) occurred between distilled water 5 minutes and sodium hypochlorite 5.25% 10 minutes, between sodium hypochlorite 5.25% 5 minutes and sodium hypochlorite 5.25% 15 minutes, between distilled water 10 minutes with distilled water for 15 minutes and sodium hypochlorite 5.25% 15 minutes, and between sodium hypochlorite 5.25% 10 minutes and sodium hypochlorite 5.25% 15 minutes.

## Discussion

Alginate is the impression material most often used in dentistry, however, when it is used, contamination of the patient's blood and saliva often occurs.<sup>1,2</sup> Disinfection of impression materials is one way to prevent cross infection.<sup>1</sup>

Disinfection techniques are divided into 2 types according to the ADA, namely by spraying and soaking.<sup>2</sup> The antimicrobial effectiveness when disinfecting using the soaking method is the same as the spraying method.<sup>12</sup> Disinfection by spraying produces smaller dimensional changes compared to immersion.<sup>1</sup> The process of disinfecting alginate impression materials is an effort to eliminate dangerous vegetative and pathogenic organisms.<sup>21</sup> The disinfection technique used in this research was spraying using sodium hypochlorite solution with a concentration of 5.25% for 5 minutes, 10 minutes and 15 minutes. .

The mold results can be said to be good if the accuracy and stability of the dimensions can be guaranteed until they are filled with gypsum. Accuracy and dimensional stability of alginate is important for the overall success of the impression.<sup>1</sup> Accuracy is the ability to produce the same measuring value, while dimensional stability is the ability to maintain accuracy over a certain time interval.<sup>9</sup>

Alginate molds can experience expansion which can affect dimensional stability, this happens because alginate has imbibition and syneresis properties.<sup>2</sup> The pressure received by the alginate on the tray during the gelation process also causes changes in dimensional stability. Changes in temperature can also cause changes in the dimensional stability of alginate, these small changes can cause the mold to experience expansion or distortion.<sup>3,13</sup> In this study, researchers controlled the temperature by using water with a temperature of 23°C.

Sodium hypochlorite solution is a disinfectant solution that is often used because it is not too expensive. According to the ADA, the use of sodium hypochlorite solution as a disinfectant solution for impression materials is better than iodophor and phenol because it does not damage the surface of the impression material.<sup>4</sup> Chlorine-based sodium hypochlorite solution which is the highest data disinfectant. This ingredient works quickly and is very effective against the Hepatitis B virus and HIV.<sup>14</sup> Sodium

hypochlorite solution is a disinfection agent that is effective at moderate levels which can eliminate various types of vegetative bacteria, tubercle bacilli, fungal spores, viruses and bacterial endospores.<sup>21</sup>

The sodium hypochlorite solution must be mixed with distilled water so that it can become a disinfectant solution. The hypochlorous acid (HClO) solution that occurs when mixing sodium hypochlorite solution and distilled water is a strong oxidizing agent.<sup>15</sup> The oxygen content in the solution is a strong oxidizing agent, so that oxidation occurs which causes pressure fluctuations in the sodium hypochlorite solution. When the sodium hypochlorite solution comes into contact with the alginate impression material, the pressure from the solution will press against the impression material causing the impression to easily experience imbibition so that dimensional changes can occur.<sup>16,17</sup> Changes in diameter values can occur due to the structure of alginate in the form of fibers with water filling the capillary space.<sup>18</sup> The resulting alginate mold contains 85% water, making it possible to undergo dimensional changes.<sup>19</sup>

The alginate mold in contact with the disinfectant solution causes dimensional changes due to the absorption of the disinfectant solution which causes expansion of the impression material, where the alginate impression material contains ions such as Na, SO<sub>4</sub><sup>2-</sup>, and PO<sub>4</sub><sup>3-</sup> as osmotic potential. Osmotic pressure between the alginate and the disinfection solution causes the alginate to expand or swell.<sup>9,18</sup>

The largest change occurred in the group sprayed with distilled water solution which was disinfected for 15 minutes, namely 0.357%, while the smallest change occurred in the group sprayed with 5.25% sodium hypochlorite solution which was disinfected for 5 minutes, namely 0.16%. Based on the research results, it was found that the longer the disinfection time, the greater the dimensional changes that occurred. According to research conducted by Prabowo et al which states that 5 minutes of alginate disinfection is the ideal time because the contact between the alginate mold and water is relatively short, resulting in slight dimensional changes.<sup>19</sup> The dimensional changes that occurred after spraying 5.25% sodium hypochlorite for 5 minutes, 10 minutes and 15 minutes were still tolerable because the changes that occurred were still in the range of 0.16-0.26% in line with

research conducted by Santoso et al which also compared time disinfection of alginate impression materials.<sup>20</sup>

ADA standard no. 18 states that the impression material must not experience a dimensional change of more than 0.5% of the material cast size, because this will affect the success of subsequent stages of work such as making full dentures and partial dentures.<sup>3</sup> The largest percentage change occurred when spraying distilled water solution for 15 minutes, namely 0.357%, where the percentage change in this dimension was still within the standard limits set by ADA number 18. This can happen because during disinfection by spraying the imbibition and syneresis processes occur in a balanced way, so that this does not occur significant change.<sup>1</sup>

## Conclusions

In conclusion, the disinfection time can influence changes in the dimensional stability of the alginate impression. Disinfection of alginate with 5.25% sodium hypochlorite solution with a disinfection time of 5 minutes is considered good because it experiences little dimensional changes.

## Declaration of Interest

The authors report no conflict of interest.

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