

## **An *In-Vitro* Study on the Dimensional Stability of Self-Disinfecting Alginate Materials Using Different Concentrations of Chlorhexidine Solutions**

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### **Abstract**

The aim of this study was to compare the dimensional changes in casts poured from irreversible hydrocolloid impression materials internally disinfected with different concentrations of chlorhexidine. In this *in vitro* study, type IV dental stone casts (Elite Stone, Zhermack) were fabricated from irreversible hydrocolloid impressions of Frasco typodont dentulous model. The irreversible hydrocolloid powder (Kromopan, Lascod Italy) was mixed with four different concentrations of chlorhexidine solution at 0.05%, 0.10%, 0.15% and 0.2%. Distilled water was used as control. Twenty casts were made for each mixing solution. Four measurements including cross arch width (AB and CD) and sagittal plane distance (BC and DA) were measured with a Mitutoyo digital caliper with accuracy up to 0.01 mm. Data was analyzed using SPSS version 22. ANOVA and Post Hoc Tukey's test were used to compare the mean differences among the groups. The mean cast measurements showed no significant difference in any of the three out of four measurements among the groups with different concentrations of chlorhexidine solutions, with p values being 0.716, 0.64 and 0.35 respectively. However, the DA measurement was significant with p = 0.002. Different concentrations of chlorhexidine solutions used to internally disinfect hydrocolloid impression materials have no significant impact on the dimensional stability of the casts.

**Keywords:** Irreversible Hydrocolloid Impressions; Dental Stone Casts and Chlorhexidine Solution

### **Introduction**

Elastic impression materials are needed to produce an imprint, providing high definition details despite the presence of undercuts. Elastic impression materials include reversible (agar-agar), irreversible (alginate) hydrocolloids and synthetic elastomers (polysulfides, polyethers, silicones) [1]. Alginate impression materials are most commonly used because they are easy to use, less expensive and have more rapid setting times [1]. Impression materials are commonly contaminated with microorganisms such as *Streptococcus*, *Escherichia coli*, *Staphylococcus*, *Actinomyces*, *Pseudomonas*, *Klebsiella* and *Candida* commonly seen in the oral cavity [2]. Impression material exposed to infected saliva and blood is a significant source of infectious agents [3]. Based on a survey carried out among dental technicians, there

is lack of awareness on basic infection control among most of the technicians [4]. Moreover, dental technicians are not satisfied with the impression disinfection practices [3].

A questionnaire based study revealed that only about half of the dental clinics had some type of disinfection routines, while the rest rinsed in running water only [5]. Poor training of laboratory staff in disinfection techniques, along with the lack of communication between the dental team and dental laboratory personnel may directly affect the results of prosthesis [6]. This goes to show that, besides providing dental technicians better instructions and education of the importance of maintaining a cleaner working environment when handling material that may contain infections agents, a more coherent method of disinfecting impression materials; specifically alginates is vital.

Following the American Dental Association (ADA) basic guidelines [7] the methods of disinfecting impressions can be widely categorized into spraying and immersion. Commonly used chemical agents are sodium hypochlorite, iodophors, glutaraldehyde, chlorine compounds, phenols, alcohols, chlorhexidine and ozonated water. Typically, mode of action of these disinfectants are disruption of the cell membrane, protein coagulation and removal of the free sulfhydryl groups and substrate competition [8]. Immersion disinfection ensures that all surfaces of the dental impression are exposed to the disinfectant; however, hydrocolloids and polyether materials cannot be immersed in disinfectants due to the imbibition phenomenon. Immersion disinfectants should be discarded after every use (except for glutaraldehyde). Immersion disinfection is time consuming and expensive because in need of newly prepared disinfectant and has to be changed frequently. The spray method of disinfection, may not reach the areas of undercuts and also releases air, leading to occupational exposure [8,9].

Moreover, using these methods for disinfecting has its own drawbacks to the patients and dental team. Most commonly observed are irritation to the skin and mucous membrane. Besides that, chances of inhalation of vapor and manipulation toxic disinfectant puts the health of the dental team at risk [8]. It is recommended that internal disinfection by replacing water with disinfectant solution before taking impression as the preferred method for alginate disinfection [10]. This allows for immediate pouring after removing the impression from the oral cavity, thus reducing any sort of dimensional changes that may occur via immersion or spraying disinfection methods. A study by Amalan A, Ginjupalli K and Upadhya N used four different types of disinfectants (chlorhexidine at 0.1% and 0.2% and sodium hypochlorite at 0.1% and 0.5%) mixed with alginate to evaluate its properties. It was found out that using 0.1 and 0.5% sodium hypochlorite as the disinfectant increased gel strength, reduced surface detail reproduction and gelation time [11]. However, the permanent deformation observed was clinically acceptable. Whereas with chlorhexidine solution, increased gelation time, decreased gelation and no significant changes in detail reproduction was observed [11]. In a study by Hussien A., *et al.* disinfectant solutions used were 1%, 5%, 10%, 15% and 20% Povidone Iodine powder which shows significant dimensional changes at 20% [12]. Increase in permanent deformation was noted when 1%, 2% and 5% of silver nanoparticles were incorporated in the mixture in a study done by Kishore Ginjupalli., *et al* [11]. Study done by Jian Wang., *et al.* with 0.1% Chlorhexidine containing irreversible hydrocolloid impression material possessed surface antibacterial effects on eight tested microbial species [13]. In consistent with that, 0.1% of Chlorhexidine was sufficient to inhibit the growth of most of the isolated organisms from the alginate powder [4]. Therefore, chlorhexidine solution can be used to mix irreversible hydrocolloid impression materials in regular dental practice as it did not significantly alter the properties and ensure effective disinfection of impressions.

## **Materials and Methods**

In this study we used a modified articulator similar in study conducted by Wandrekar., *et al.* 2014 [14] (Table 1). The modified articulator in the study was a non-adjustable hinge type articulator with the maxillary model mounted onto the upper rim of the articulator. The lower portion of the articulator consisted of an acrylic housing supported by metal pins and attached to the lower member of the articulator. This housing was used to position stainless steel perforated L size stock trays for the impression procedures (Figure 1). This modified articulator ensured accurate positioning of the tray and uniform pressure during impression making [15]. Irreversible hydrocolloid

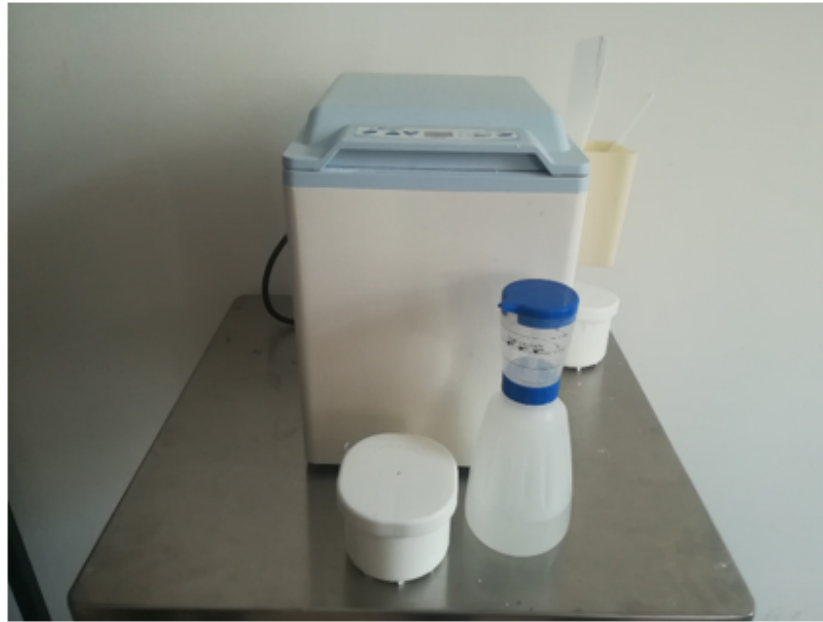
impressions were made with Kromopan, Lascod Italy with a powder to solution ratio of 27 g to 60 ml. 5 different solutions were used to mix the alginate as: Distilled water (control group), Modification of 0.05% chlorhexidine, Modification of 0.1% chlorhexidine, Modification of 0.15% chlorhexidine and Modification of 0.2% chlorhexidine. The chlorhexidine mixing solution was prepared from dilution of 0.2% Pearlie White Alcohol Free Chlor-Rinse Mouth Rinse with distilled water. The consistency of the mixture was standardized by using a Blendex automatic alginate mixer (Figure 2) to mix the powder and liquid for 8 seconds, followed by loading of material to the stock tray and impression making. Impression was allowed to set for 5 minutes before separation from the model (Figure 3).

Reference Point	Anatomic landmark
A	Buccal cusp tip of maxillary right first premolar
B	Buccal cusp tip of maxillary left first premolar
C	Distobuccal cusp tip of maxillary left first molar
D	Distobuccal cusp tip of maxillary right first molar

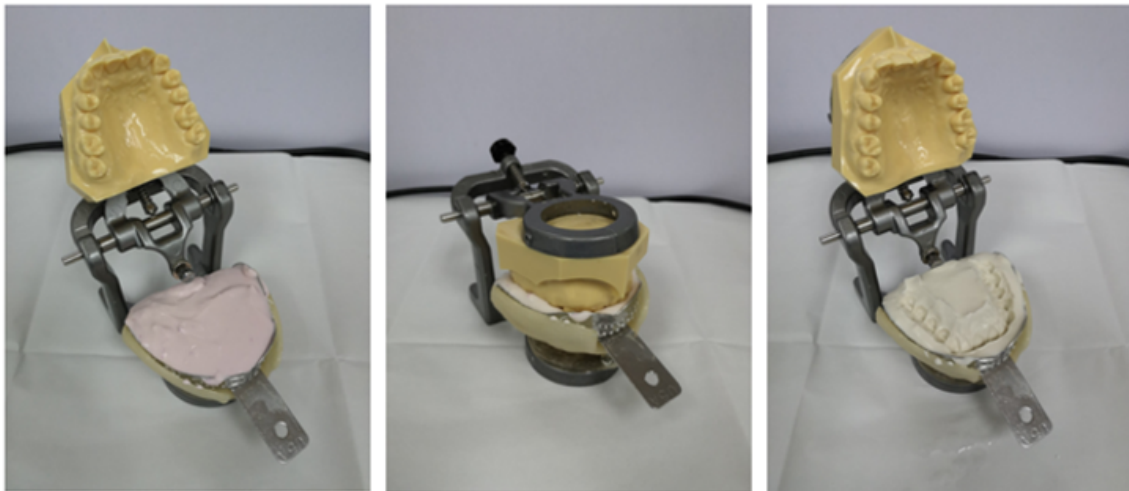
**Table 1:** Four reference points were used.



**Figure 1:** Modified articulator with mounted Frasaco typodont dentulous model.



**Figure 2:** Blendex automatic alginate mixer.



**Figure 3:** Alginate impression material loaded in the stock tray. Impression was made and separated after 5 minutes of setting time.

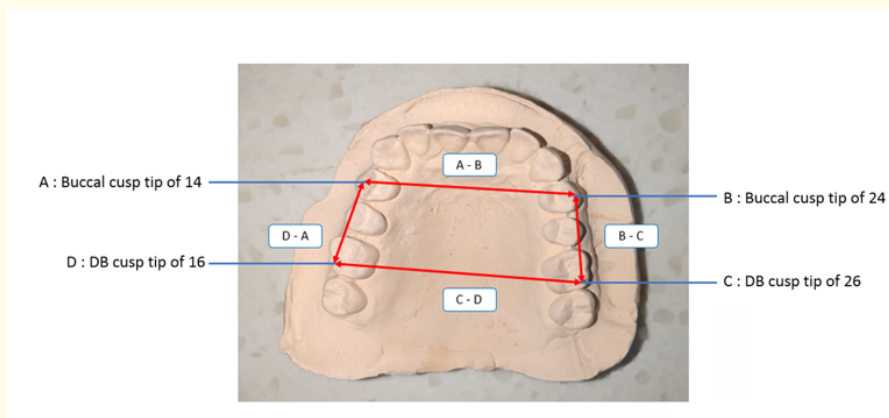
Twenty impressions were made for each solution, with the dental stone casts poured after 5 minutes of setting time. Type IV dental stone (Elite Rock, Zhermack) were used with a powder-liquid ratio of 100g to 22 ml of tap water. The stone casts were separated from the impression material after two hours from the casting time (Figure 4). The stone casts were allowed to set for at least 48 hours at room temperature before measurements were made to allow expansion of the stone (Table 2 and figure 5).

Measurement	Significance
A-B	Premolar cross arch distance
C-D	Molar cross arch distance
B-C	Left sagittal plane
D-A	Right sagittal plane

**Table 2:** Four measurements were made and tabulated (measurements to be attached) with respect to the above reference points with a Mitutoyo digital callipers with accuracy up to 0.01 mm.



**Figure 4:** Casting was done after separation from the model and left for 2 hours before separation from the impression.



**Figure 5:** Reference points A, B, C and D were plotted on the cast (blue). Measurements were made from point A-B, B-C, C-D and D-A (red).

**Statistical analysis**

The data was analysed by using SPSS version 22. One-way ANOVA test was used to compare the difference in mean between 5 groups. Post Hoc Tukey’s test was used to elicit a significant mean difference between individual groups.

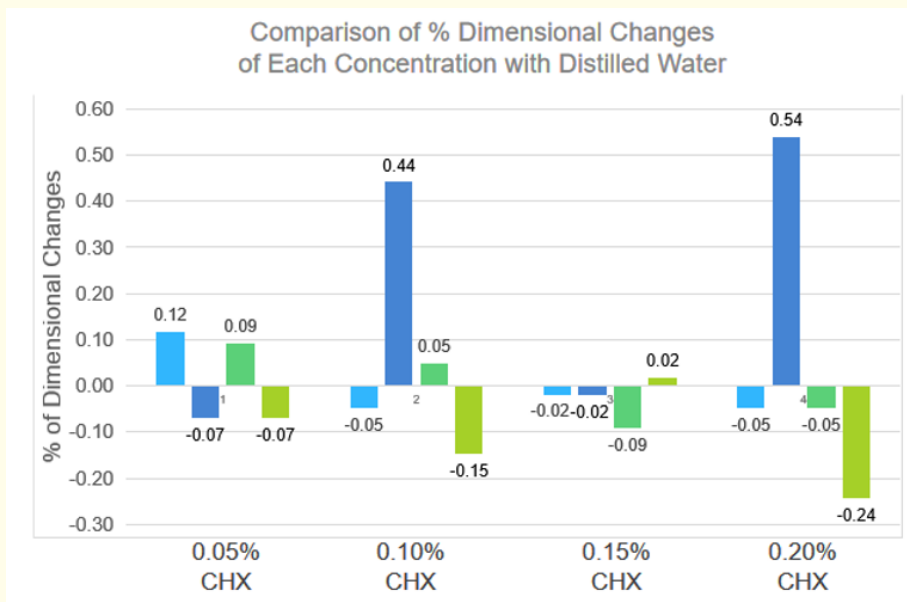
**Result**

When a one-way ANOVA test was used to compare the difference in mean between 5 groups, the following p values were found (Table 3). The only significant difference was found at the DA segment, with  $p < 0.05$ .

Dimensions	Segment	P value
Transverse Plane	AB	0.716
	CD	0.357
Sagittal Plane	BC	0.064
	DA	0.002

**Table 3:** One-way ANOVA used to compare the difference in mean between 5 groups.

When the Post Hoc Tukey’s test was done to analyse the difference in DA segment, it was found that dimensional changes were lower in lower concentrations compared to higher concentrations in DA segment. On the other hand, we compared the dimensional changes (in percentage) for each group with the distilled water group (control group), we found a range of change from 0.54% to -0.24% (Figure 6).



**Figure 6:** Dimensional changes (in percentage) for each group with the distilled water group (control group).



## Discussion

The consistency of the mixture was standardized by using a Blendex automatic alginate mixer to mix the powder and liquid for 8 seconds. This eliminates any human error or variation in mixing time and method. Alginate impressions prepared with automatic mixing method have better dimensional accuracy than those mixed by hand [16].

The modified articulator similar to the one used in a study conducted by Wandrekar, *et al.* 2014 was used to ensure accurate positioning of the tray and uniform pressure every time the impression is made [14]. The mixing conditions were kept constant by mixing Type IV dental stone (Elite Rock, Zhermack) using the powder-liquid ratio of 100g to 22 ml of tap water [17]. All stone casts were removed from the impression material after two hours from the casting time. Then, the stone was allowed to set for at least 48 hours at room temperature before measurements were made, to allow expansion of the stone. All mixing was done under fixed temperature, in a lab setting at room temperature and humidity. There was significant dimensional change found only in segment D-A. The reason for this change is not known. Other similar studies produced by Jian Wang, *et al.* [13], Amalan A., *et al.* [18] and Ramer and their colleague [19] showed no significant changes in dimension. The maximum dimensional change in the plane D-A is 0.54%. Nonetheless, the maximum clinical acceptable deformation according to the American Dental Association specification number 18 [7], is 3% and on the other hand, according to a study performed by Alcan., *et al.* [20], a percentage of dimensional change ranging from 0.48% to 0.90% is clinically acceptable.

## Conclusion

Different concentrations of chlorhexidine solutions used to internally disinfect hydrocolloid impression materials have no significant impact on the dimensional stability of the casts.

## Limitations of the Study

Only one brand of irreversible hydrocolloid material, chlorhexidine mouthwash solution and dental stone was used in the study.

## Recommendations

We would like to recommend more various brands of materials to be used for further studies, as well as to investigate the possible reasons for the isolated significant change in the DA segment.

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