ORIGINAL ARTICLE

EVALUATION OF THE DIMENSIONAL STABILITY OF ALGINATE IMPRESSION MATERIALS IMMERSED IN VARIOUS DISINFECTANT SOLUTIONS

[1]SHAHREEN ZAHID
[2]SAMIE QADIR
[3]NIDA ZEHRA BANO
[4]SABA WAQAR QURESHI
[5]MUHAMMAD KALEEM

ABSTRACT

This study was aimed to investigate the effect of two different disinfectant agents on the dimensional stability of commercially available modern alginate impression materials in terms of syneresis and imbibition. Two disinfection agents; Chlorox® (5.25%sodium hypochlorite) and Practice safe®, (alcohol based) were used to assess the dimensional stability of five commercially available alginate impression materials including Cavex CA37®, Cavex Color Change®, Tulip®, Cavex Cream Alginate®, and TOL®. Artificial Saliva treated samples were used as control group. To obtain a measure of imbibition, weights of sample discs of the impression materials were measured before and immediately after disinfection. For syneresis, disinfected sample discs were weighed at thirty minutes and then after a twenty four hour time interval. Repeat Measure Analysis of variance was employed to identify statistically significant differences within groups and across groups. The results have shown that all impression materials showed minimum change in weight while treated with Chlorox®, whereas Practice safe® caused large changes in weight. Cavex Cream® Alginate showed minimum change immediately after disinfection, but after thirty minutes, Cavex CA 37®showed the overall least change in weight. It can be concluded that Chlorox® should be preferred over Practice safe® as a disinfectant medium for newer alginates. Cavex Cream® Alginate disinfected with Chlorox® is the most stable immediately after disinfection, but Cavex CA 37® disinfected with Chlorox® is more ideal for delayed pouring. However, further research related to the comparison of detail reproducibility is recommended.

Key Words: *Alginate, Dimensional Stability, Disinfection, Disinfectants, Impression.*

INTRODUCTION

Alginate impression materials have served as a facile tool for recording oral and dental anatomy in a convenient, inexpensive and patient-friendly mode. Despite these advantages, certain drawbacks of this irreversible hydrocolloid have led to efforts to improve the properties of conventional alginates.[1,2] These have resulted in the production of a variety of new alginate products.

These newer alginate products are being marketed with the pretext of having certain qualities that make them superior to the conventional alginates. The superior properties of latest material vary from improved handling properties such as silica dust free, improved setting characteristics such as extended pour time to accuracy and dimensional stability.

From amongst the latest alginate impression material, Cavex Color change® offers extended pour time, with colour change indicator showing end of mixing and setting time and accuracy of minimum 25 µm and dimensionally stable for up to 9 days. Other latest materials like Cavex CA37®, Tulip® and TOL® are claimed to be dust free. This silica, present in diatomaceous form, can cause silicosis if inhaled for prolonged periods[3], while Cavex CA37® also reproduces detail at least 50µm according to the manufacturers. Another material is

[1] Shahreen Zahid, Assistant Professor Dental Materials, Army Medical College, National University of Medical Sciences, Rawalpindi
[2] Samie Qadir, Assistant Professor, Dental Materials, Margalla Institute of Health Sciences, Rawalpindi
[3] Nida Zehra Bano, Postgraduate Trainee, Dental Materials, Army Medical College, National University of Medical Sciences
[4] Saba Waqar Qureshi, Senior Registrar, Department of Dental Materials, Margalla Institute of Health Sciences
[5] Muhammad Kaleem Assistant Professor, Dental Materials, Head of Department Dental Materials, Army Medical College, National University of Medical Sciences

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Cavex Cream Alginate®, which is claimed to show a 5µm detail reproduction. All the latest materials with different improvements in their properties claims to have superior dimensional stability.

However, disinfection after recording an impression may lead to distortions.[4] On the other hand if not properly disinfected, the dental impression is one of the most highly contaminated objects that are transported from the dental clinic to the lab. It has been shown that 67% of all material sent from the dental surgery to the laboratory is contaminated0.[5] The intensity of exposure risks associated with impressions that may be contaminated with saliva and/or blood have led to the formulation ofvarious disinfection protocols specified by authorities such as International Dental Federation (IDF) and American Dental Association (ADA).[6] Alginate impression materials are regulated by ISO 1563:1990 and their properties are described in ANSI/ ADA specification no. 18-1992. Different disinfection protocols regarding the type of disinfectant as well as the disinfection method have been suggested for alginate. Current American Dental Association infection control guidelines recommend immersion disinfection of irreversible hydrocolloid impressions.[7]

In some studies, the immersion of the impression in the disinfectant solution has been considered superior to spraying disinfectant over the impression. This is due to the fact that immersion is more effective in reaching all parts of the impression, including undercuts, which may harbor a significant number of microorganisms. However, immersion also leads to more distortion of the impression compared with spraying. This is due to the hydrophilic properties of the alginate products that allow the water content in the set product to change by imbibition and syneresis.[3,8] This phenomenon may be explained by the fact that an ionic gradient exists between the alginate and the soaking solution and to equalize the ionic levels, the water molecules travel across the material.[9]

The effect produced by imbibition and syneresis on the dimensions of the impression and on the overall detail reproduction on the cast has been studied with varying results. Some studies agree that the effect produced is negligible, and the thorough disinfection of the impression should not be compromised by preferring to spray rather than to immerse. Other studies, however, have shown that a considerable dimensional change can be caused by the immersion technique.[4] The time for which the disinfection takes place may also be a contributing factor[10,11] Generally, the immersion of the impression in sodium hypochlorite solution for ten minutes has been considered acceptable.[3]

The limited literature available on latest material is controversial. A study showed that Cavex Color change® material, when compared with conventional alginate did not produce statistically different dimensional change on day 5 negating the claim of manufacturer.[12] Another study showed that this irreversible hydrocolloid had higher dimensional change values when compared with Blueprint, Cavex CA37, Jeltrate, Orthoprint, Cavex Orthotrace, and Tetrachrom.[13] Yet another study presented no statistical differences between the dimensional changes produced by Jeltrate Plus, Hydrogum 5, and Cavex Color Change[14], wheras another concluded that Cavex Color Change and Hydrogum 5 could be poured for up to 96 hours.[15] Due to this variety of data available, more research is needed in order to assess the effects of different disinfectants on these newer alginate products. This would substantiate the limited data available to the dentists that can aid in selection of an appropriate disinfection medium for each of the newer alginate products.[16]

It has been shown previously that the antimicrobial efficacy of alcohol based disinfectants is similar to that of sodium hypochlorite.[17] However, the decision to select an appropriate disinfection system for a particular product also depends upon the physical effects that it may have on the impressions created. The present study was designed to evaluate and compare the dimensional changes due to imbibition and syneresis in five new commercial alginate products, and to assess the effect of two different disinfectant solutions on these dimensional changes.

METHODOLOGY

The five different impression materials, with their commercial name, claimed specification and LOT number used in the study are listed in Table 1 while the 3 different media used are listed in Table 2 respectively. Table 1 illustrates five different types of commercially available alginate impression materials (alginate groups). For the purpose of study, the impression specimens have been divided into three main groups on the basis 3 different impression medium (consisting of 10 samples each n=10).

Group A; Specimens treated with practice safe

Group B; Specimens treated with Clorox

Group C; Specimens treated with artificial saliva

A round disc shaped plastic split mould (dimensions H =4mm, W= 6mm,) was used to prepare disc shaped identical samples. All the samples were treated same via immersion technique. All of the alginate samples were allowed to set for 5 minutes inside the water bath at 98.6°F (37°C) to simulate the setting environment of the oral cavity.

Group A was treated by immersion in disinfectant Practice safe® (alcohol based disinfectant) as per manufacturer's instructions. Group B was treated by immersion in Clorox® (5.25% sodium hypochlorite at

1:10 dilutions) as per manufacturer's instructions and Group C was treated by immersion in artificial saliva for the given amount of setting time at 98.6°F (37°C) to simulate the oral environment. After the preparation of samples, the initial weight for each sample was measured using an electronic analytical balance (OHAUS PA 84 Pioneer, batch no 514783092) and was denoted as W1.

After the immersion of all specimens, in each of the three media for the given amount of time according to the manufacturer instructions, the samples were weighed again and the percentage weight change for each sample in each of the three different media was calculated. The samples were weighed again using electronic analytical balance (OHAUS PA 84 Pioneer, batch no 514783092) after a time period of 30 minutes and 24 hours. The percentage weight change at 30 minute and 24 hour intervals were calculated respectively. Statistical analysis was performed using SPSS version 22, using the repeat measure ANOVA test.

RESULTS

There was a significant difference between the groups ($p<0.05$). Practice safe® caused more dimensional changes in the samples as compared to Chlorax®. Moreover Practice safe®had a weight reducing effect while Clorox®had an imbibatory effect on all impression materials except TOL®, as shown in Fig 2. Small increase in weight was recorded in all samples except TOL® after treatment with Clorox® immediately and after thirty minutes' immersion as shown in Fig 7.

Cavex Cream® Alginate showed smallest percent change after thirty minutes when disinfected with Chlorox® showing a much lesser effect and should be preferred over the ethanol-based Practice safe®. TULIP® also showed imbibition on treatment with both artificial saliva (0.45%) and Chlorox® (2.51%),

TABLE 1: FIVE (GROUPS) COMMERCIALLY AVAILABLE NEWER ALGINATES TESTED IN THIS STUDY

S. No.	Group Number	Commercial Name	Claimed Specification	Lot No.	Standardization body
1	I	Cavex CA37® (Holland)	Normal Set Dust free	150518	ISO Specification 1563
2	II	CavexColorChange® (Holland)	Fast Set Dust Free	160220	ISO Specification 1563
3	III	Tulip® (Holland)	Dust Free Elastic	150873	ADA NO.18 ISO 1563
4	IV	Cavex Cream Alginate® (Holland)	Normal Set Dust free	160509	ISO Specification 1563
5	V	TOL® (China)	Fast set Dust free	1505181	FDA Approved ISO Specification 1563-1990 ADA NO.18

TABLE 2: THREE IMMERSION MEDIA (SUBGROUPS) TESTED IN PRESENT STUDY

Sub Group	Type of immersion medium	Manufacturer	Composition	Concentration (%)	Imm-ersion Time	Lot No.
A (n=10)	Practice safe®	Kemdent	Ethanol, Didecylidimethyl ammonium chloride Alcohol based fast spray disinfectant Aldehyde & Phenol free	4.5	3 min	222780
B (n=10)	Clorox®	Clorox house hold bleach	Sodium hypochlorite	5.25 1:10 dilutions	10 min	104560
C (n=10)	Artificial saliva (Control)	Prepared in the laboratory	Sodium chloride Potassium chloride Potassium thiocyanate Potassium dihydrogen orthophosphate Urea Calcium chloride Sodium sulphate Sodium Hydrogen Carbonate Ammonium chloride	—	45s -1 min	Lab Prepared

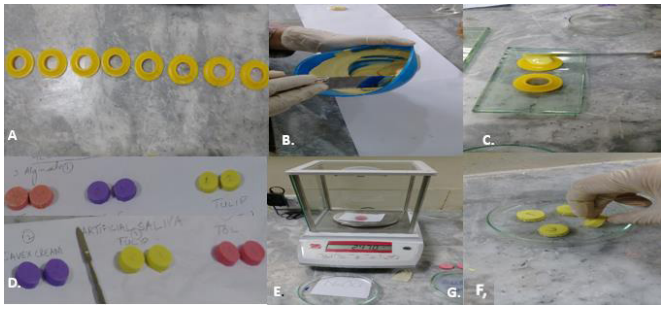

Fig 1A: Split moulds used in study; B. Alginate impression material being mixed in a rubber bowl by spatula; C, Alginate being poured into the moulds; D, Disc shaped samples obtained; E, Measurement of initial weight of the sample using analytical weighing balance (OHAUS PA 84 Pioneer, batch no 514783092) ; F, Three immersion media used in the study; G, Immersion of alginate samples into each of three media

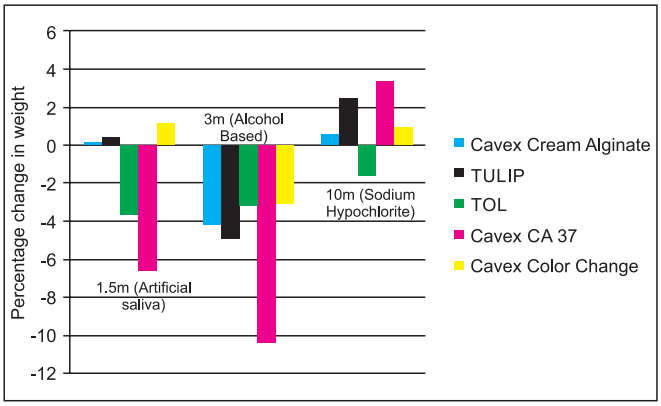

Fig 2: Showing a comparison of percentage change in weight when samples were treated with different immersion media according to the instructions of the manufacterers of the media. Significant difference was found between the groups ($p<0.05$)

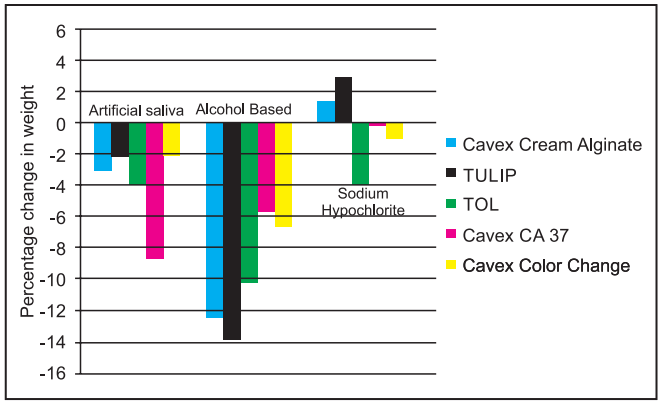

Fig 3: Showing a comparison of percentage change in weight found when the disinfected samples were left in air for thirty minutes. Significant difference was found between the groups ($p<0.05$)

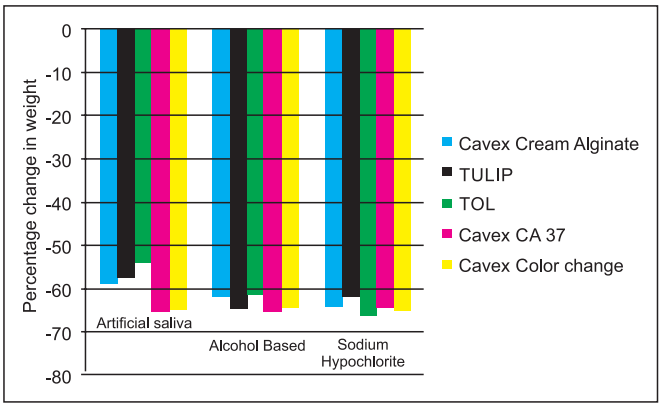

Fig 4: Showing a comparison of percentage change in weight found when treated samples were left in air for 24 hours. Significant difference was found between the groups ($p<0.05$).

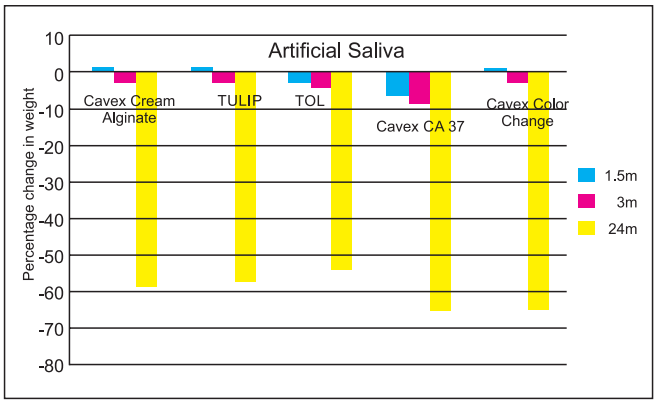

Fig 5: Showing a comparison of the percentage change in weight when samples were treated with artificial saliva for 1.5 minutes, and then left in air for thirty minutes and twenty four hours. Significant difference was found between the groups ($p<0.05$).

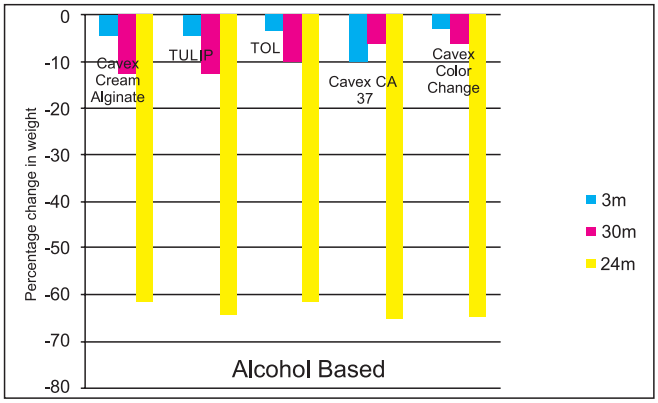

Fig 6: Showing a comparison of the percentage change in weight when samples were treated with alcohol based disinfectant for 3 minutes, and then left in air for thirty minutes and twenty four hours. Significant difference was found between the groups ($p<0.05$).

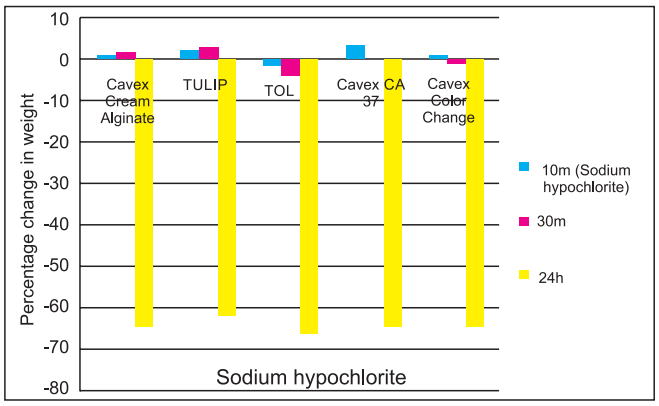

Fig 7: Showing a comparison of the percentage change in weight when samples were treated with Chlorox® for 10 minutes, and then left in air for thirty minutes and twenty four hours. Significant difference was found between the groups ($p<0.05$).

and a much larger drop in weight with Practice safe®. TOL® exhibited a significant drop in weight when treated with all three immersion media. However, the drop was least while treated with Chlorox® (-1.62%) as compared with Practice safe® (-3.22%) or artificial saliva (-3.68%). Cavex CA 37® exhibited the least dimensional change with Chlorox®. These results are summarized in Fig 2-7).

DISCUSSION

The disinfection of alginates with sodium hypochlorite solution is acceptable in most instances. This study highlights that the newer alginates, though possessing improved qualities, are also liable to undergo changes due to water absorption or shrinkage. Imbery et al found similar results while testing one of these materials, Cavex Color Change®, which showed initial expansion which decreases over time.[12]

From amonst the myriad of published chairside disinfection systems available for the dental clinic today[18], sodium hypochlorite has been proven to effectively eradicate pathogenic microorganisms from impressions in the dental setup.[17,19-22] It has been shown previously that the antimicrobial efficacy of alcohol-based disinfectants is almost similar to that of sodium hypochlorite.[17] Furthermore, sodium hypochlorite-based disinfection has been shown to have an effect on the dimensional stability of alginate products.[4,23] In this study, comparison of an alcohol-based disinfectant was done with sodium hypochlorite in terms of imbibition and syneresis. All materials showed the largest change in weight after disinfection when treated with alcohol-based Practice safe®, and the lowest when treated with sodium hypochlorite-based Chlorox®. Therefore Chlorox® may be selected as the better disinfectant medium from amongst the two tested disinfectants.

High values of shrinkage were shown by all samples treated by Practice safe® at all times. This shrinkage was towards the center of the samples. In the clinical set-up, the shrinkage of the material of an impression would be towards the tray, causing increase in the dimensions of the tooth area of impression and decrease in the palatal dimensions.[12] Therefore Practice safe® may not be recommended for the disinfection of these products. Chlorox® should be considered the ideal option.

The difference in the weight changes shown by the different materials may be explained by the differences in the calcium: sodium ratios.[24] The effect of additives, such as colour indicators may also play a role.[25] The technique of disinfection (immersion) may also effect the result, as it has been shown previously that atleast two of these materials CA37 and Color Change may be poured for up to 24 hours without changes being produced in the final cast.[26]

From amongst all the materials tested, the least change in weight after disinfection was observed when Cavex Cream® Alginate when treated with Chlorox®. However, interestingly after the thirty minute interval, the weight increased to 1.45% which was much more than the total change in weight observed in Cavex CA 37® after thirty minutes (-0.11%). Therefore, it can be said that the dimensional change in Cavex Cream® Alginate was observed to be the minimum immediately after disinfection, but after thirty minutes, Cavex CA 37® showed the overall least change in weight.

Nassar et al have shown in a systematic analysis that newer alginate products have the capability of allowing the user to delay the pouring time.[27] Similar results were published by da Costa et al.[15] It was shown that Cavex CA37® may be the material of choice for delayed pouring as this material showed the least overall change after a delay of thirty minutes.[27] However all materials, including Cavex CA 37 showed very large changes after 24 hrs. Sedda et al compared five alginate products including Cavex CA 37 and found that this material did not comply with the master cast after 24 hours.[28] This is in accordance with the results of the present study. Therefore Cavex CA 37may be suggested for pouring delayed for shorter time intervals.

However, the fact that Cavex CA 37®underwent a weight change that was later reversed after a time delay does not mean that any dimensional change that had occurred will also be reversed or nullified. Further studies, including detail reproduction studies are required to confirm the results of the present study.

CONCLUSION

Within the limitations of this study, it can be concluded that the disinfection of alginate impression with Clorox® will cause lesser dimensional changes

related to syneresis and imbibition. Cavex Cream® Alginate is the impression material of choice if it is to be poured immediately after disinfection while Cavex CA 37® may be preferred for delayed pouring.

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CONTRIBUTIONS BY AUTHORS

1 Shahreen Zahid:	Conception, statistical analysis
2 Samie Qadir:	Experimental work
3 Nida Zehra Bano:	Experimental work and writing methodology
4 Saba Waqar Qureshi:	Article writing
5 Muhammad Kaleem:	Supervisor