

EFFECT OF POURING TIME ON DIMENSIONAL CHANGES IN IRREVERSIBLE HYDROCOLLOID IMPRESSION MATERIAL AFTER TREATMENT WITH DISINFECTANT

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ABSTRACT

Objectives: To assess the effect of pouring time on dimensional changes of alginate impression material after disinfection.

Materials and Methods: A total of twenty impressions were made using alginate impression material. The impressions were divided into four groups designated as A, B, C and D. Group A (control) impressions were poured with dental stone immediately after rinsing with tap water. In group B and D impressions were poured after applying disinfectant spray at 10mins and 1hr delay. Group-C impressions were poured after one hour without spraying disinfectant. All the impressions were poured in dental plaster. The dimensional changes in the diameter and height of the raised column and the distance between two lines were recorded on using a digital Vernier caliper with 0.01mm accuracy. P value less than 0.05 was taken as significant.

Results: The diameter of the raised column in various groups showed insignificant changes ($p > 0.05$) when compared to each other except group D which showed significant dimensional change on comparison with group A ($p < 0.05$). Similarly C-D distance and height of the raised column exhibited insignificant changes when compared to each other ($p > 0.05$)

Conclusion: The dimensional stability of the alginate impression material was affected neither by the application of disinfectant nor by delaying pouring up to one hour after taking the impression.

Key words: Alginate impression material, Dimensional stability, Disinfection, Irreversible hydrocolloid

INTRODUCTION

Disinfection of impression materials is essential due to presence of microorganisms in or on the impression material from blood or saliva¹. However, if not appropriately disinfected, the impression of the patient is one of the highly contaminated objects transported from the dental clinic to lab. It has been shown that 67% of all materials sent from dental clinic to the laboratory are contaminated². About 44.7% of labs stated that they never disinfect impressions as majority of the lab owners (53%) believe that

impression disinfection is the responsibility dentist or dental technician³.

Currently, two types of disinfecting methods are available i.e aerosols and immersion in disinfecting solution. Ideally the dimensional stability should not be affected by either of these two methods. Dimensionally changes take place in alginates after immersion in artificial saliva and water¹.

American Dental Association have suggested various disinfection protocols due to intensity of exposure risks linked with dental impressions that may come in contact with saliva and/or blood⁴. Some studies reported that disinfection by immersion in disinfectant is more effective than spray disinfectant. But there is more possibility of distortion of the impression in immersion due to hydrophilic properties of the alginate when compared with spraying^{5,6}. The

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possible explanation of the phenomenon might be the fact that an ionic difference exists between the soaking solution and the alginate and to maintain equilibrium, the water molecules move across the material⁷.

Sensible application of knowledge and experience about the properties of dental materials are essential for the fabrication of successful prosthesis. Fabrication of cast for a dental arch precisely, plays an important role in successful execution of various dental treatments. Due to time limit, clinicians do not perform cast making by themselves and prefer to send impression for cast making to the laboratories⁸. In those labs where disinfection was practiced, 32.6% used immersion disinfection whereas 51% used spray disinfection³. Consequently, considerable delay occurs in pouring the cast after recording the impression, leading to dimensional changes in the impression, thereby affecting the dimensional accuracy of the prosthesis⁸.

The present study aimed to evaluate the dimensional changes after the application of disinfectant by spray method and to assess the effect of delay in pouring dental stone in disinfected alginate impression material. Thus, the null hypothesis of the study was that there would be no difference in the dimensional stability of alginate impression material after application of disinfectant and delay in pouring the dental stone in disinfected alginate impression material.

MATERIALS AND METHODS

This was an experimental laboratory based study conducted in Department of Dental Materials Peshawar Dental College June, 2022. A total of twenty impressions were recorded of acrylic resin die (Fig: 1) using alginate impression material (Hygedent/ High

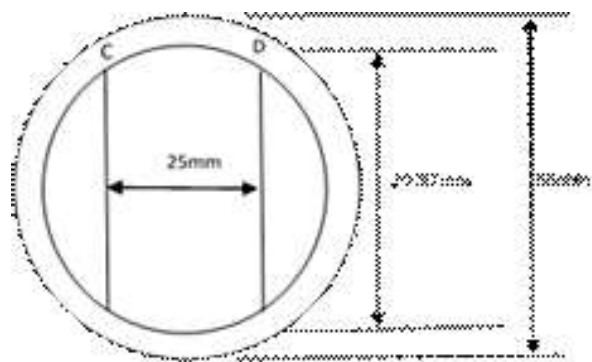


Fig 1:

elasticity/Dust free) based on ADA specification no 19¹². The water/ powder ratio (10g/22ml) and mixing time (30sec) was used according to manufacturer's instructions. The impressions were divided into four groups designated as A, B, C and D. The group A (control) impressions were poured with dental stone (Kopo Hard CHK-52 Kuang Pang) immediately after rinsing with tap water while the group B impressions were poured after applying disinfectant spray (Reprodis HLD 4I UK) for 10mins. Group-C impressions were poured after one hour without spraying disinfectant while group-D impressions were poured one hour after application of disinfectant spray. All the samples were kept in air conditioned room with average temperature ranging in between 18-20°C, without humidity control. The material was placed in an impression tray and the die placed into the impression tray. The whole apparatus was kept at room temperature (38.48°C) during the setting time. After the setting time, the die was separated and rinsed in the running water for 10 seconds. The impressions were poured in dental stone and then next impression was recorded. The dimensional changes in the diameter and height of the raised column and the distance between two lines were determined in the casts of all four groups using a digital Vernier caliper¹². Impressions of the die without any distortion and in which area required for measurement was clear were included in this study while the exclusion criteria involved those dies containing bubbles and in which areas to be measured were distorted. Statistical analysis was performed using one way ANOVA and post hoc Tukey's test using Statistical Package for Social Sciences (SPSS) version 20. P value less than

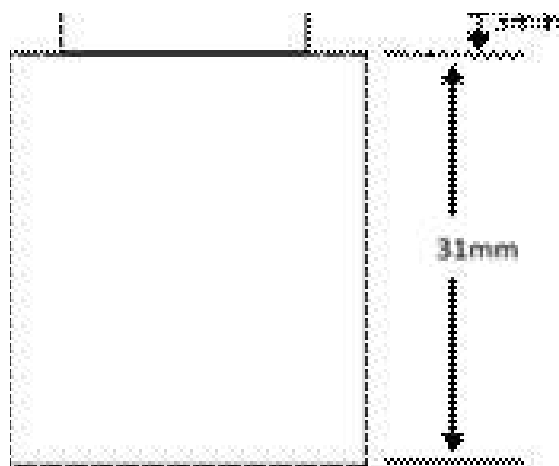


Fig 2:

Table-1. Mean and S.D values for diameter, height of the raised column and the distance between C-D lines on the raised column

	Group A (Control) (Poured Immediately without disinfection)	Group B (Poured Ten minutes after disinfection)	Group C (Poured after one hour with out disinfection)	Group D (Poured one hour after disinfection)	F	p-value
Diameter of raised column (mm)	27 ± 0.16	26.60 ± 0.85	26.81 ± 0.15	26.20 ± 0.85	01.821	0.184
C-D distance (mm)	10.60 ± 0.13	10.60 ± 0.45	10.72 ± 0.35	10.60 ± 0.48	0.175	0.912
Height of raised column (mm)	4.20 ± 4.10	4.35 ± 0.32	4.34 ± 0.14	4.16 ± 0.20	1.111	0.374

Table-2. Statistical analysis using post hoc Tukey's test for diameter of the raised column.

Diameter of raised column	Groups (I)	Groups (J)	Mean difference	p-value
	A	B	0.416	0.265
		C	0.188	0.609
		D	0.798	0.041
	B	C	-0.22	0.535
		D	0.382	0.304
	C	B	0.228	0.535
		D	0.610	0.109
	D	B	-0.38	0.304
		C	-0.61	0.109

Table-3. Statistical analysis using post hoc Tukey's test for C-D distance.

C-D Distance	Groups (I)	Groups (J)	Mean Difference	p-value
	A	B	0.032	0.896
		C	-0.12	0.610
		D	0.01	0.961
	B	C	-0.15	0.523
		D	-0.02	0.935
	C	B	0.15	0.523
		D	0.13	0.576

0.05 was considered as significant.

RESULT

This laboratory based experimental study was planned to evaluate time dependent dimensional stability of the irreversible hydrocolloid alginate impression material after application of disinfection.

Table-4. Statistical analysis using post hoc Tukey's test for height of the raised column.

Height of the raised column	Groups (I)	Groups (J)	Mean Difference	p-value
	A	B	-0.16	0.243
		C	-0.14	0.279
		D	0.03	0.823
	B	C	0.01	0.929
		D	0.19	0.170
	C	B	-0.12	0.929
		D	0.17	0.197

The dimensional changes in the height and diameter of the raised column and the distance between C and D lines present on raised column in various experimental groups have been presented in Table 1.

Statistical analysis (Table 2, 3 & 4) of the values for the diameter of the raised column in various groups shows insignificant changes ($p > 0.05$) when compared to each other except group D (impressions poured after one hour of spraying disinfectant) which shows significant dimensional change on comparison with group A ($p < 0.05$). Similarly C-D distance and height of the raised column exhibited insignificant changes when compared to each other ($p > 0.05$) (Table 2).

DISCUSSION

Irreversible hydrocolloid impression materials are hydrophilic in nature that can capture surface details of soft and hard tissue in the presence of moisture. These impression materials are economical and can readily be used by following the manufacturer's directions. Low tear resistance, dimensional

instability when pouring delayed and the failure to produce precise casts when repoured are some of the concerns associated with these materials¹³. Variables like powder to liquid ratio, water temperature while mixing, storage time, humidity control and storage temperature can influence the final product properties especially dimensional stability¹⁴.

The results of this study demonstrated that the dimensional stability of the conventional alginate impression material is affected neither by the application of disinfectant nor by delaying the pouring up to one hour after taking the impression except the difference between group A and D for diameter of the raised column which was found to be significantly different, thus partially rejecting the null hypothesis. Although the impression show over all dimensional stability but storage up to 1hr after spray disinfection, without humidity control can affect the recorded surface details of alginate impression material. The impression group which has been poured immediately was used as a control. Traditional alginate impressions exhibits dimensional stability when poured immediately¹². Other studies have reported dimensional stability of traditional alginate even after 30 minutes of storage¹⁵.

According to a study done by sayed et al, the extended storage alginate under humidity control and uncontrolled humidity condition for 1hr did not significantly influence the dimensional precision of the resultant stone casts. In their study the effect of disinfectant was not investigated¹⁶.

On contrary, while comparing conventional vs. extended storage alginate under humidity control vs. no control, both showed significant contraction on storage beyond 15 min. The negative linear dimensional change (contraction) was verified after 24hr of storage (1.32% for the traditional alginates and 1.52% for the high stability alginate). Both alginates reproduced the 75 μ m groove at all storage periods¹⁷.

Earlier studies done on dimensional stability of cast produced from conventional set irreversible hydrocolloids, disinfected by spray technique using iodophor and phenol group over 10, 30 and 60 minutes showed no significant difference in dimensions¹⁸. Al-Nema used 0.05% iodine, 0.5% chlorhexidine and hydrochloride for mixing alginate. The set material statistically had no difference in dimensions, whereas 0.5% sodium hydrochloride group showed maximal

change inform of expansion¹⁹.

Cohen et al investigated the dimensional stability of various irreversible hydrocolloid impression materials under multiple storage conditions. Impressions were stored for different times as 10 min, 30 min, 1hr and 24hrs before pouring. They reported that most precise cast was produced when impression was poured immediately^{9,10}. Jamani et al¹¹ explored the best storage condition and time for pouring dental plaster in irreversible hydrocolloid impression. The impressions were casted at 3hrs, 1hr, 30 min and 15 min after recording the impression. The results demonstrated that irreversible hydrocolloid impression material could be used as a final material if it was poured within 15 minutes.

When compared to control all the groups showed slight expansion. The reason might be that alginate itself contains water, there might be an early expansion, due to presence of ions in alginate (e.g. Na⁺, SO₄²⁻, PO₄³⁻) producing an osmotic potential. Later on, ions move out in to the surrounding water due to which osmotic potential is reversed, so that some water diffuses out again¹.

While comparing different brands of alginate and disinfectant, it was concluded that almost all commercial available disinfectants leads to noticeable dimensional changes in the alginates as compared to other elastomers. While disinfecting alginate, chemical nature of disinfectant can also significantly influence the dimensional stability of alginate impression material. Because of lack of knowledge about detailed composition of materials under investigation, the possible explanation of different behaviors shown by the material during disinfection is difficult. The dimensional changes could be related with filler/alginate ratio, or ratio of Na/Ca ions. Imbibition phenomena could be due to increasing free water present between fillers in alginate impression and the percentage of surfactant in alginate impression material²².

It is difficult to evaluate precisely the dimensional stability of the disinfected impressions because of variation in laboratory studies such as specimen dimensions, base-line measurements, method of measurement and reporting, the osmolarity of disinfectant, pH of disinfectant as well as thickness of impression²⁰. A common method and protocol unanimously approved by researchers must be developed

to evaluate the results and to compare it with other studies¹⁵.

The die used in the study was made based on ADA specification no 19, however the standards for alginate impression materials contain no requirement for dimensional stability. The American Dental Association's specification number 18 and the International Organization for Standardization's 1563:1990 deal specifically with dental alginate impression materials used in dentistry to make impressions of the teeth and tissues of the oral cavity; however, neither has any limits on dimensional changes. The American Dental Association's specification number 19 is different in that it governs elastomeric impression materials and specifies that the dimensional change of a material should be less than 1.5% at 24 hours²¹. The standard for elastomeric materials tests the impression material change by using a test die similar to the method used in this study, however, measurements were done with Vernier caliper instead of travelling microscope in the study.

International standards are deficient on guidance of hydrocolloids dimensional stability. With introduction of new technology and varying types of commercially available irreversible hydrocolloids impression materials, international standards need to specify properties like dimensional stability, surface details recording and use of compatible disinfectant type. Since this was an in vitro study, an exact simulation of the oral conditions in terms of mouth temperature, existence of blood, saliva, soft tissues, and undercuts could not be achieved to evaluate the studied impressions in an idealized model

One of the limitation of this study was that the acrylic die was used instead of using metallic die. Acrylic resin has higher coefficient of thermal expansion which may influence the outcome of the study. Furthermore, since the chemical composition of the disinfectant was not provided by the manufacturer due to which it was not possible to elaborate possible explanation of the interaction between the disinfectant and the impression material. This study might be helpful to clinicians and laboratory staff using disinfectant spray (Repro dis HLD 4I UK) in understanding the influence of the disinfectant on the dimensional stability of alginate impression material.

Further studies are required to access the dimensional stability of irreversible hydrocolloids

impression materials in oral simulation, taking in consideration the variation in material thickness, application of tray adhesives, osmolarity and pH of disinfectant.

CONCLUSION

Within the limitation of this study, it was concluded that the dimensional stability of the conventional alginate impression material is affected neither by the application of disinfectant nor by delaying the pouring up to 1 hour after taking the impression.

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