Original Article

Comparative Study of the Effect of Storage Environment Temperature on the Accuracy of Hygedent and Chromogel Alginate Impression Materials

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ABSTRACT

Background and Aim: Considering the lack of sufficient and even contradictory studies on the effect of temperature-dependent dimensional changes of alginate before pouring, this study aimed to investigate the effect of storage temperature of Hygedent and Chromogel alginate molds on dimensional stability.

Materials and Methods: In this in-vitro experimental study, dimensional changes of two types of alginate were investigated indirectly by measuring a type III stone cast. Ninety molds of each alginate were obtained from a metal model and stored at 1±4, 1±25, and 1±40°C. The casting was performed 12 minutes, 1 hour, and 4 hours after impression taking. The molds were incubated with an approximate humidity of 100%. The diameter, width, and height of the gypsum casts were measured by a digital caliper with an accuracy of 0.01 mm. Dimensional changes of two alginates in three separate directions were statistically analyzed by three-way analysis of variance (ANOVA) and post-hoc test due to the significant difference.

Result: There was no statistically significant difference in width changes at different temperatures, but regarding the diameter, there was a significant difference between 40°C Chromogel and 25°C Hygedent. Regarding the height, only 40°C Hygedent showed a significant difference at 4 hours compared to 12 minutes (P=0.000, 0.26, and 0.000, respectively). However, no statistically significant difference was observed in other temperatures and times (P>0.05). In most groups, dimensional changes of all samples were not within the clinical standard range (1%).

Conclusion: It seems that the dimensional stability of Hygedent and Chromogel alginates is affected by storage temperature, pouring time, and type of alginate.

Keywords: Alginate, Temperature, Time, Dimensional Stability

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Introduction:

One of the important factors in choosing impression materials, such as alginate, is the level of dimensional changes. Lack of dimensional stability of alginate may lead to repetition or an increase in operating time and cost.

To achieve an accurate impression, it is important to be aware of all the factors that may affect the dimensional accuracy of the material. These factors include ambient temperature and humidity, pouring time, and type of alginate.[1-3]

The best ambient temperature mentioned is 2±23°C, and the researchers' recommendation based on preliminary studies was that to maintain dimensional accuracy, the irreversible hydrocolloid impression should be poured immediately or within 12 minutes at 100% humidity.[4-6] Some sources allow the impression to be stored in a humid environment for about 1-2 hours and in some cases less than 5 days for long-lasting alginates.[7,8] Because, in some cases, it is not possible for dentists to quickly access laboratory facilities for the pouring of impressions, it is necessary to use impression materials that maintain their dimensional stability with temperature and time changes.

So far, several studies have been conducted on the factors affecting the dimensional stability of alginate. One of them is the study of Penfold et al on the dimensional stability of three types of alginates at different temperatures and times.[7] They found that the dimensional stability of the alginate was affected by the storage temperature and pouring time and was similar for different alginates. The study of Kulkarni and Thombare on dimensional changes of three types of alginates at different temperatures and times showed that between three temperatures of 25, 30, and 40°C, only 25°C included non-significant changes compared to the original model.[1] Farzin and Panahandeh found that a humid environment and temperature of 4°C could delay impression pouring. [6]

In the study of different alginates, the results were somewhat similar and in some cases different. Considering the relatively contradictory studies on the simultaneous effect of temperature and time on alginate and the lack of sufficient research on Hygedent and Chromogel alginates, we aimed to study the effect of storage temperature on the dimensional stability of Hygedent and Chromogel alginate impression materials.

Materials and Methods:

In this in-vitro experimental study, dimensional changes of Hygedent alginate (Hygedent Inc., China) and Chromogel alginate (Marlik Dental, Iran) were indirectly investigated using type III stone cast (Tara, Iran).

In this research, 90 molds of each alginate were prepared from a metal model made of stainless steel, which included two cut metal bases with a distance of 11.10 mm, a diameter (large) of 5.13 mm from the apex, a height of 11.10 mm, and a convergence angle of 3 degrees. There were two guide bars on either side, which created an insertion-and-removal path and a 2mm distance as a spacer.[9]

The upper part was made of metal and had holes at a distance of 1cm on all surfaces, which played the role of a custom tray (Figure 1).[1]

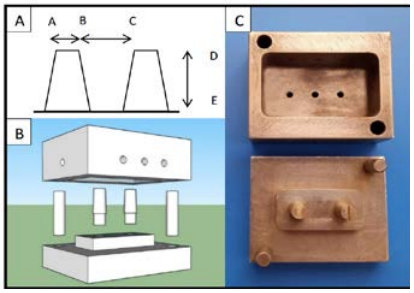

Figure 1: Metal model. (A) Two-dimensional (2D) schematic figure. (B) 3D design. (C) The final model.

In all groups, the alginate was mixed and prepared according to the manufacturer's instructions with distilled water of 22±1°C; the water temperature was determined by a thermometer (Iran Electronic Technique; Table 1).[10,11]

Molding was performed by applying pressure with a weight of 2kg during the setting time.[7]

The molds were then washed with water for 10 seconds.[12] The molds were stored at different temperatures of 1±4, 1±25, and 1±40°C and then poured at intervals of 12 minutes, 1 hour, and 4 hours after molding, during which time the molds were placed in an incubator with an approximate humidity of 100%. [7]

Molding was performed 10 times in each group. After 1 hour, the casts were separated from the molds.[13]

After the casts were completely dry for 24 hours, [5] according to Figure 1, the diameter (A-B), width (B-C), and height (D-E) on the gypsum casts were measured thrice by a digital caliper (Mahr, Germany), and the mean was considered (Figures 2, and 3).

Figure 2: Steps of molding, plastering, and cast preparation. (A) Molding with Hygedent alginate. (B) Molding with Chromogel alginate.

Figure 3: 180 pieces of gypsum cast

Molds with large bubbles were excluded from the study, and the molding was repeated. Dimensional changes of Hygedent and Chromogel alginates in three separate directions were statistically analyzed by three-way analysis of variance (ANOVA) and post hoc test due to the significant difference. The metal model was used as a reference.[1,12]

Results:

This in-vitro experimental research involved 180 gypsum casts obtained by pouring of two types of alginate, Chromogel and Hygedent, in equal numbers at three temperatures of 4, 25, and 40°C and three times of 12 minutes, 1 hour, and 4 hours, and sampling was performed 10 times in each group.

Dimensional changes of diameter, width, and height were determined, and the differences with the original model (as a reference) were statistically analyzed

The average dimensions are presented in Table 2, the average changes in Table 3, and the clinically acceptable percentage in Table 4 at different pouring temperatures and times by alginate type.

A) Diameter:

For Hygedent at 25°C, changes at 4 hours were significant compared to 12 minutes (P=0.023). The lowest average change between different times was related to 12 minutes, and the maximum was at 4 hours.

For Chromogel at 40°C, changes at 4 hours and 1 hour were significant compared to 12 minutes (P=0.000 and 0.002, respectively). The lowest average change between different times was related to 12 minutes, and the maximum was at 4 hours.

According to the latest standard of ISO/FDIS 21563 hydrocolloid impression materials for 2013, the maximum linear dimensional variation is 1%; considering this, there was no group with samples that were 100% within the clinically acceptable range regarding the diameter

Changes between the two substances at 1 hour and 25°C were significant (P=0.012), and in this case, Chromogel showed fewer changes than Hygedent. B) Width:

The width at different times, temperatures, and materials did not show a statistically significant difference (P>0.05). However, the highest mean changes on the gypsum cast were related to Chromogel alginate at 40°C and 4 hours, and the lowest mean changes were related to Hygedent alginate at 4°C and 1 hour.

C) Height:

For Hygedent at 40°C, changes at 4 hours were significant compared to 12 minutes and 1 hour (P=0.000). The lowest average change between different times was related to 1 hour, and the maximum was at 4 hours.

The changes between the two substances at 4 hours and 4°C were significant (P=0.033), and in this case, Chromogel showed fewer changes than Hygedent.

Table 1: Instructions for preparing alginate mixture according to the manufacturer's instructions

Alginate	Powder (g)	Water (ml)	Mixing time (second)	Working time (second)	Setting time (second)
Hygedent	10	22	30	60	90
Chromogel	7	15	35	60	60

Table 2: Average diameter, width, and height (mm) at different temperatures and follow-up times by type of alginate

Alginate	Temperature	Time	Mean ± SD Diameter	Width	Height
Metal model (reference)			**5.13**	**11.10**	**11.10**
Chromogel	**1℃ ±4**	**12 minutes**	5.08±0.08	11.13±0.05	11.13±0.05
		1 hour	5.09±0.05	11.12±0.02	11.13±0.02
		4 hours	5.09±0.05	11.12±0.04	11.11±0.02
	1℃ ±25	**12 minutes**	5.12±0.04	11.11±0.04	11.12±0.03
		1 hour	5.10±0.02	11.12±0.03	11.13±0.07
		4 hours	5.13±0.06	11.10±0.03	11.12±0.02
	1℃ ±40	**12 minutes**	5.14±0.03	11.09±0.03	11.18±0.04
		1 hour	5.04±0.05	11.15±0.05	11.15±0.04
		4 hours	5.00±0.04	11.17±0.06	11.01±0.07
Hygedent	**1℃ ±4**	**12 minutes**	5.14±0.05	11.10±0.06	11.11±0.04
		1 hour	5.15±0.06	11.09±0.02	11.12±0.07
		4 hours	5.17±0.04	11.06±0.03	11.06±0.04
	1℃ ±25	**12 minutes**	5.11±0.04	11.12±0.04	11.12±0.04
		1 hour	5.07±0.04	11.14±0.03	11.15±0.06
		4 hours	5.05±0.02	11.15±0.05	11.15±0.03
	1℃ ±40	**12 minutes**	5.07±0.03	11.13±0.04	11.14±0.02
		1 hour	5.08±0.07	11.13±0.04	11.12±0.02
		4 hours	5.17±0.05	11.07±0.04	10.92±0.08

SD:Standard Deviation

Table 3: Mean changes (mm) at different temperatures and follow-up times by alginate type

Alginate	Temperature	Time	Mean ± SD		
			Diameter	Width	Height
Chromogel	1°C ±4	12 minutes	0.0553±0.07	0.0447±0.04	0.0400±0.03
		1 hour	0.0503±0.04	0.0213±0.02	0.0303±0.02
		4 hours	0.0490±0.04	0.0273±0.03	0.0173±0.02
	1°C ±25	12 minutes	0.0360±0.02	0.0293±0.02	0.0303±0.03
		1 hour	0.0283±0.04	0.0277±0.03	0.0437±0.06
		4 hours	0.0457±0.04	0.0248±0.02	0.0241±0.02
	1°C ±40	12 minutes	0.0230±0.02	0.0213±0.02	0.0913±0.06
		1 hour	0.0907±0.05	0.0537±0.05	0.0507±0.04
		4 hours	0.1273±0.04	0.0733±0.06	0.0830±0.04
Hygedent	1°C ±4	12 minutes	0.0290±0.04	0.0330±0.05	0.0263±0.03
		1 hour	0.0493±0.03	0.0167±0.01	0.0393±0.06
		4 hours	0.0527±0.02	0.0433±0.03	0.0420±0.04
	1°C ±25	12 minutes	0.0357±0.02	0.0387±0.03	0.0373±0.03
		1 hour	0.0637±0.04	0.0407±0.03	0.0603±0.05
		4 hours	0.0757±0.02	0.0577±0.04	0.0507±0.03
	1°C ±40	12 minutes	0.0593±0.03	0.0357±0.03	0.0437±0.02
		1 hour	0.0797±0.04	0.0497±0.02	0.0241±0.02
		4 hours	0.0463±0.04	0.0367±0.03	0.1777±0.08

Table 4: Clinically acceptable percentages according to temperatures and follow-up times by type of alginate

Alginate	Temperature	Time	Clinically acceptable percentage		
			Diameter	Width	Height
Chromogel	1°C ±4	12 minutes	60	100	100
		1 hour	60	100	100
		4 hours	60	90	100
	1°C ±25	12 minutes	80	100	100
		1 hour	90	100	90
		4 hours	80	100	100
	1°C ±40	12 minutes	90	100	90
		1 hour	20	80	90
		4 hours	0	70	90
Hygedent	1°C ±4	12 minutes	80	90	100
		1 hour	50	100	90
		4 hours	50	100	90
	1°C ±25	12 minutes	80	100	100
		1 hour	60	100	70
		4 hours	10	90	100
	1°C ±40	12 minutes	50	100	100
		1 hour	20	100	100
		4 hours	60	100	10

SD=Standard Deviation

Discussion:

This in-vitro experimental study revealed that Chromogel at 25°C shows more acceptable clinical changes in the diameter compared to the other two temperatures, and the higher the temperature, especially 40°C, the difference between 12 minutes and 4 hours becomes significant so that there is no adaptation at 40°C and 4 hours. Therefore, it is recommended to pour the impression at 40°C within 12 minutes. If we want to keep the mold longer, the same ambient temperature (25°C) is recommended. The temperature of 4°C also seems appropriate because it has not made significant changes at different times. Hygedent dimensional changes showed different results than Chromogel, with the best temperature being 4°C and the best time being 12 minutes. Regarding the diameter, at 4 and 25°C, the clinically acceptable percentage decreases over time. Nevertheless, the changes at 40°C were uncertain and not very consistent with time. Of course, the changes in the diameter may have improved at 40°C, but regarding the height, it has undergone many changes; In any case, high temperatures and the passage of time have led to unacceptable changes. In addition, Chromogel showed statistically fewer dimensional changes than Hygedent.

According to our study, in terms of clinically acceptable range, the most changes occurred in the diameter whereas the width and height were less subjected to changes. However, even if one dimension changes unacceptably, it causes the prepared cast to be slightly compatible with the original model.

For decades, researchers have believed that alginate dental molds should be poured with gypsum immediately or within 12 minutes after molding due to the inherent properties of alginate.[12]

In 2012, Atashrazm et al compared the dimensional stability of AriaDent and Bayer alginates. All the impressions were poured within 10-20 minutes.[14] They stated that alginate dimensional changes up to about 1.8% are acceptable. (14) In the study of Imbery et al, in 2010, on the dimensional stability of two types of alginates, Cavex Color Change (extended-pour) and Jeltrate Plus (conventional), in immediate impression pouring and five other time intervals, the maximum acceptable changes were considered 0.5%. (12) According to ADA No. 19, this number is less than 1.5% for elastomeric materials in 24 hours.[2]

In 2010, Farzin and Panahandeh concluded that the dimensional stability of Golchai Iranian alginate is affected by pouring time and storage temperature.[6] They examined the dimensional stability of alginate in the anterior-posterior and cross-arch dimensions at 12, 25, 45, and 60 minutes after molding and at two storage temperatures of 23 and 4°C. They concluded that, statistically, the anterior-posterior dimension, unlike the cross-arch dimension, is affected by the storage temperature and pouring time, so that at 4°C, only the 60-minute interval had a statistically significant difference with the control group. However, the temperature of 25°C did not show any significant difference with the control group only at 12 minutes.[6] In our study, the temperature of 25°C caused significant changes in one of the dimensions, but the temperature of 4°C caused no statistically significant changes in any dimension. This difference can be attributed to the difference between the alginate material used and the different dimensions considered.

Todd and colleagues achieved different results.[2] They examined the dimensional changes of Kromopan, Triphasix (extended-pour), Jeltrate, and Kromatica (traditional) alginates at temperatures of -9, 22, and 46°C and at times of 10 minutes, 24 hours, and 100 hours. They found that the temperature of -9°C caused the most changes, and the temperature of 22°C caused the least changes, and there were no statistically significant changes at 10 minutes. In their study, the samples were exposed to the set temperatures only in the first 8 hours, and they were kept at room temperature for the rest of the time; no reference or reason was specified for this part of their working method.[2]

Kulkarni and Thombare also evaluated the dimensional accuracy of three types of alginates, Velplast, Marieflex, and Zelgan, at 20 and 40 minutes and three temperatures of 25, 30, and 40°C.[1] The result was that the least changes in different temperatures are related to the time of

20 minutes, in which no significant difference was observed between different temperatures, and the time of 20 minutes and temperature of 30°C, compared to 40°C, showed the closest number to the original model. Between different temperatures, only 25°C included insignificant changes compared to the original model.[1] These temperature changes have differences and similarities with the present study that may be related to the type of alginate used.

Amirian et al studied the effect of different impression storage times of 15, 30, 60, 120 minutes, and 24 hours on the dimensional accuracy of two types of alginates, Tropicalgin and Chromogel, and concluded that the average difference between the two materials at all times, except for the first 15 minutes, is significant in at least one dimension.[8] On the other hand, the difference in size with the original model in all dimensions was not within the clinical standard range at 24 hours only (except for one dimension, which was within the standard range all the time). They also found that under the same conditions, Tropicalgin (Italy) was preferable to Chromogel.[8]

In 2018, Penfold et al examined the dimensional stability of three types of alginate, Cavex Color Change, Jeltrate Plus, and Hydrogum 5, immediately and at 1, 3, and 5 days and two temperatures of 25 and 37°C.[7] The result was that the immediate time and temperature of 25°C rendered the highest dimensional stability. However, the molds were still dimensionally stable for up to 5 days at 25°C. The different brands of alginate studied did not show a statistically significant difference regarding the dimensional stability.

We considered the maximum linear dimensional change of 1% according to the latest standard of ISO/FDIS 21563 hydrocolloid impression materials for 2013. In the present study, the only group with samples that were not clinically acceptable was the 40°C Chromogel at 4 hours (diameter).

It seems that with increasing the temperature up to 40°C, unacceptable dimensional changes occur after 4 hours, which may affect the diameter in some alginates, such as Chromogel, and the height in others, such as Hygedent. Therefore, we do not recommend a temperature of 40°C and a time of 4 hours.

Various studies have not specified how to store impressions at different temperatures and humidity, [1,2,6,7,10] but in the present study, impressions that were stored at different temperatures were incubated with an approximate humidity of 100% until being poured. Different tools have also been used to measure the accuracy of the impression material in different studies. Mehraban Jahromi et al, in their study, which compared the effect of storage time on dimensional changes of two different types of alginate impression material, used a digital caliper with an accuracy of 0.01mm. [5] We also used a similar digital caliper (10µm accuracy) to measure the dimensions, which increased the statistical accuracy of the research.

Conclusion:

In the scope of our study, it seems that the dimensional stability of Hygedent and Chromogel alginates is affected by storage temperature, pouring time, and type of alginate. Although it is better to pour the alginate faster, the pouring time has different effects on alginates. If pouring is not possible immediately after molding, it is necessary not to increase the pouring time above a certain limit depending on the type of alginate. Also, the alginate brand has some effect on the proper storage temperature. Statistically, Chromogel has smaller dimensional changes than Hygedent, but clinically, it seems that in both materials, with increasing the temperature up to 40°C and time up to 4 hours, unacceptable dimensional changes occur.

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