The Effect of Storage Time on the Dimensional Stability of Zinc Oxide Eugenol Impression Material Under Dry and Moist Conditions - An In-Vitro Study

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Abstract

Introduction: Accurate impression is an important factor to fabricate accurate dental casts and ultimately accurate dental prostheses. Due to time constraints, sometimes there is need of storing impression for some time which may alter the dimension. The objective of this study was to evaluate the dimensional stability of zinc oxide eugenol impression paste at different time intervals and in two conditions, dry and wet storage.

Methods: Sixty study molds of zinc oxide eugenol impression material were prepared according to American dental Association specification no 19 for non-aqueous elastic dental impression materials and the distance between two specific lines were measured at different time intervals. The paired t test was utilized to assess the difference in mean dimension of the molds from specified time to the original measurement immediately after setting.

Results: In dry storage condition, the dimensional changes were not seen up to 24 hours, but at 36 hours, there is statistically significant dimensional change. In wet condition, there was significant change in dimension after 6 hours onwards.

Conclusion: The dimensional change was not significant up to 24 hours in dry condition. Thus, it can be poured up to 24 hours after setting. Dimensional stability was not seen after 6 hour and hence is recommended to pour within 30 minutes if kept under wet condition.

Key words: Dimensional stability, Storage time, Storage condition, Zinc oxide eugenol impression paste

Introduction

An accurate record of dimensional characteristics of oral and dental structure is of utmost importance in many fields of dentistry, including prosthodontics.[1] Most of the prosthodontic treatments starts with routine procedure of making an impression which is then poured with gypsum or epoxy resin material to produce a positive reproduction(replica) of oral tissue called as dental casts.[2] To fabricate accurate dental prosthesis for rehabilitation of an edentulous area, precise impression of the hard (dental) and soft tissue taken with impression material of superior dimensional stability is required.[3,4] Use of impression materials with inadequate dimensional stability and accuracy increases the costs of treatment due to the need for repeating the impression and re-fabrication of the prosthesis or the need for modifications. Thus, impression making plays an important role in fabrication of an accurate prosthesis

Conflict of Interest: None

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and minimizes the costs and complications of prosthetic treatment.[5,6]

Different impression materials are available in the market with different composition and characteristics. Metal oxide paste have extensive applications in dentistry.[7] The availability of zinc oxide eugenol paste dates back to 1930's and have become increasingly popular in impression making procedure of denture prosthesis.[8]

An impression material must have dimensional stability to cause the overall success of the cast made from it. The polymerization shrinkage of zinc oxide eugenol paste is insignificant following setting and has reported to be less than 0.1%.[6] This results in their optimal dimensional stability.

Because of time constraint, dentists or dental students have preference to send the impressions to the laboratories rather than pouring themselves. Thus, during transfer of impression to the laboratories considerable delay can occur and thus dimensional changes can be expected which may result in dimensional inaccuracy of the prostheses.[3]

Moreover, dental impressions are to be disinfected by the disinfectants. To disinfect the impression, it is either sprayed or immersed in the disinfectant solutions. The wettability of disinfectants can also hamper the dimensional stability.[9]

This study was conducted to assess the effect of storage time on dimensional stability of impression made with zinc oxide eugenol impression paste under wet condition and dry condition.

Methods

This is an experimental in-vitro study conducted at the laboratory of Department of Prosthodontics and Crown-Bridge, B.P. Koirala Institute of Health Sciences (BPKIHS). The ethical approval for the study was obtained from institutional review committee of BPKIHS (IRC/1246/018). The total duration of the study was four months. A study mold was prepared according to revised American dental Association specification no 19 for non-aqueous elastic dental impression materials.[10] It consists of a ruled block (AA), test material mold (BB) and a riser (CC). All parts were of stainless steel. The ruled block was having three horizontal lines of different width (Fig 1). Small Y line, medium X lines and thick Z lines and two vertical lines CD and C'D'. The lines CD and C'D' were separated from each other by 25 mm (Fig. 2). The test mold was a cylinder of inner diameter of 30mm and depth of 6 mm to place the impression material. The riser was stainless steel disk of diameter 29.9mm and thickness of 3mm.

Preparation samples

Zinc oxide impression paste (DPI Impression paste, India) was mixed as instructed by manufacturer (mixing time of 45 sec, working time of 2¼ min) and applied to mold which was placed in ruled block (Fig. 3) and stored in an incubator (temperature maintained at 37˚C at humidity 100%) under 1 kg load until completion of setting time. Total of 60 samples were made in a similar manner (Fig. 4) by single examiner (IKL). For moist condition, 30 samples were swiped with cotton gauze soaked in water and wrapped in wet paper towel. In both dry and wet condition conditions, the impression mold was immediately covered by polyethylene sheet.

The distance between the two vertical parallel lines CD and C'D' was measured at different time intervals i.e. immediately after setting, after 30 minutes, after 6 hours, after 12 hours, after 24 hours, and after 36 hours by using travelling microscope (Ycoo.TM) with 10x magnification (Fig. 5). Three readings were obtained from each sample by trained and calibrated single examiner (BP) and the average of these three

values were noted. All the readings obtained was tabulated and subjected to statistical analysis for comparison of dimensional stability.

Results

The dimensions of zinc oxide eugenol oxide sample block were measured for three times and average of three readings was recorded (Table 1). The dimension immediately after setting was considered as reference to compare its stability at different time intervals. So, the mean difference of the distance between two vertical lines at specified time was compared with that taken immediately after setting by using paired t test. In dry storage condition, the dimensional changes were not seen up to 24 hours (Table 2). After 36 hours, there was statistically significant dimensional change, which is 0.31 mm and exceeded the acceptable threshold of dimensional change for metallic oxide impression material (0.1mm). However, in wet condition there was significant change in dimension after 6 hours onwards (Table 3), however the change was within acceptable threshold up to 12 hours because it was less than 0.1mm.

The dimensional change in dry and wet conditions were compared using independent sample t test at different time intervals (Table 4). It showed that there is no statistical difference between the dimensions up to 12 hours after setting ($p>0.05$). The dimensional change was significantly different in two conditions in 24 hours and 36 hours of storage ($p<0.05$).

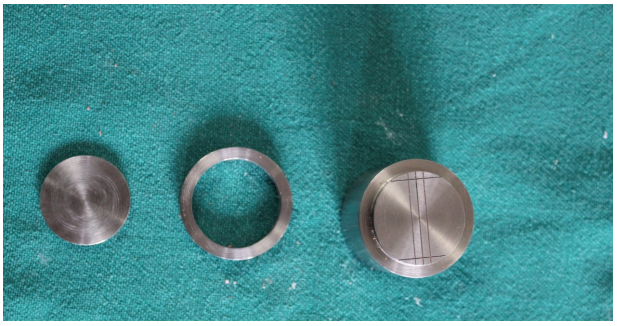

Figure 1: *The mold with three horizontal and two vertical grooves, riser and test material mold*

Figure 3: *Preparation of test molds*

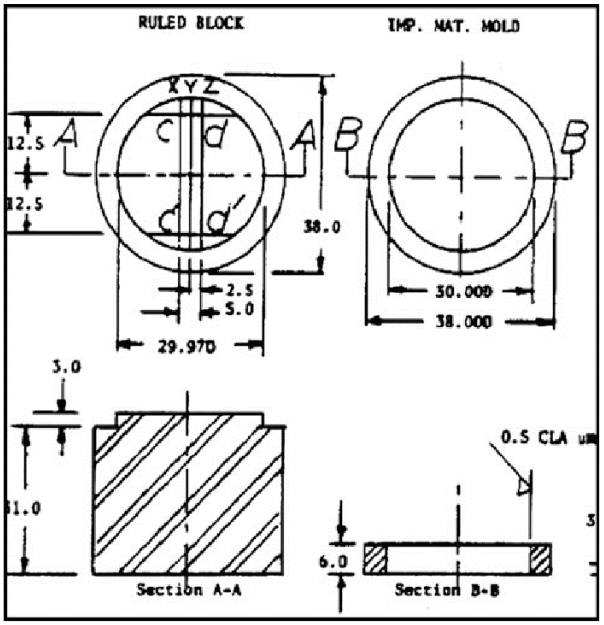

Figure 2: *Measurements of ADA specification number 19 for the fabrication of stainless-steel die*

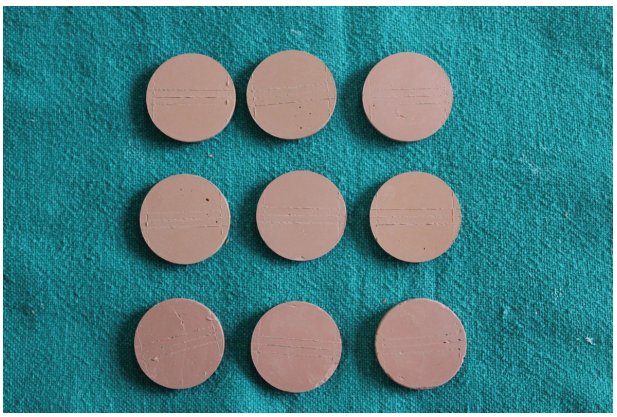

Figure 4: *Test mold samples*

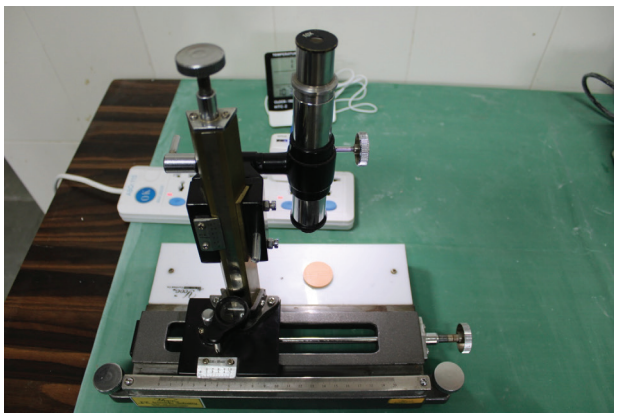

Figure 5: *Travelling microscope of 10x*

Table 1: The dimension of distance between vertical lines for each sample

Condition	Average of three measurements in mm					
	Immediately after setting	After 30 minutes	At 6 hours	At 12 hours	At 24 hours	At 36 hours
Dry condition	24.92	24.9	24.91	24.9	24.91	24.56
	24.75	24.69	24.65	24.64	24.64	24.4
	24.81	24.8	24.8	24.8	24.75	24.52
	24.86	24.83	24.83	24.8	24.65	24.48
	24.6	24.6	24.6	24.59	24.57	24.43
Wet condition	24.6	24.56	24.52	24.5	24.49	24.39
	24.56	24.53	24.5	24.5	24.36	24.31
	24.5	24.5	24.5	24.5	24.41	24.41
	24.85	24.84	24.81	24.81	24.64	24.42
	24.69	24.68	24.65	24.63	24.5	24.43

Table 2: Comparison of dimensional stability at different time intervals in dry condition

Time interval	Mean dimension of distance in mm	N	SD	Std. Error Mean	P-value
Immediately after setting	24.788	5	0.12235	0.05472	0.08
30 minutes after setting	24.764	5	0.11887	0.05316	
Immediately after setting	24.788	5	0.12235	0.05472	0.174
6 hours after setting	24.758	5	0.12911	0.05774	
Immediately after setting	24.788	5	0.12235	0.05472	0.096
12 hours after setting	24.746	5	0.12759	0.05706	
Immediately after setting	24.788	5	0.12235	0.05472	0.078
24 hours after setting	24.704	5	0.13183	0.05896	
Immediately after setting	24.788	5	0.12235	0.05472	0.001*
36 hours after setting	24.478	5	0.06496	0.02905	

P<0.05 Statistically significant

Table 3: Comparison of dimensional stability at different time intervals in wet condition

Time interval	Mean	N	SD	Std. Error Mean	P-value*
Immediately after setting	24.64	5	0.1362	0.06091	0.07
30 minutes after setting	24.622	5	0.13971	0.06248	
Immediately after setting	24.64	5	0.1362	0.06091	0.029
6 hours after setting	24.596	5	0.13502	0.06038	
Immediately after setting	24.64	5	0.1362	0.06091	0.033
12 hours after setting	24.588	5	0.13627	0.06094	
Immediately after setting	24.64	5	0.1362	0.06091	0.003
24 hours after setting	24.48	5	0.10654	0.04764	
Immediately after setting	24.64	5	0.1362	0.06091	0.01
36 hours after setting	24.392	5	0.04817	0.02154	

*P<0.05 Statistically significant

Table 4: Comparison of dry and wet conditions, Independent sample t test

Time interval	Condition	Mean± SD In mm	Std. Error Mean	P-value
Immediately after setting	Dry	24.7880±0.12235	0.05472	0.108
	Wet	24.64±0.1362	0.06091	
30 minutes after setting	Dry	24.7640±0.11887	0.05316	0.122
	Wet	24.622±0.13971	0.06248	
6 hours after setting	Dry	24.7580±0.12911	0.05774	0.088
	Wet	24.5960±0.13502	0.06038	
12 hours after setting	Dry	24.7460±0.12759	0.05706	0.095
	Wet	24.588±0.1362	0.06094	
24 hours after setting	Dry	24.7040±0.13183	0.05896	0.018*
	Wet	24.48±0.10654	0.04764	
36 hours after setting	Dry	24.4780±0.06496	0.02905	0.045*
	Wet	24.392±0.04817	0.02154	

*P<0.05 Statistically significant

Discussion

Dimensional change of impression materials after different time intervals is important because there is chance of delay in cast pouring due to time constraints and other factors. In the present study, dimensional stability of zinc oxide eugenol impression paste is compared in different time intervals in two storage conditions. Irreversible hydrocolloid was tested in similar manner keeping the impression up to seven days in low-moisture (in a humidor) and high moisture (wrapped in a wet paper towel) conditions.[11] Dimensional accuracy and surface detail production of polyvinyl siloxane was also tested in dry, moist and wet conditions.[12] Similar studies related to zinc oxide eugenol impression paste has been very less in dental literature.

Our study showed that in room temperature storage or dry condition there is not statistical difference in dimension up to 24 hours. In contrast to our study, Habibzadeh et al.[13] compared dimensional stability of zinc oxide

eugenol stored in a refrigerator or at room temperature and found that after 24 hours there is dimensional change beyond the acceptable range of 0.1mm. the difference may be due to different brands of sample and effect of temperature in different laboratory setting. In our study, it can be recommended to safely pour the impression up to 24 hours of setting without significant dimensional change if impression is maintained at room temperature.

In another study, 1:213 iodophor disinfectant solution caused less dimensional change compared to 2% Gluteraldehyde disinfectant solution.[9] In current study, the samples kept in wet conditions have no significant dimensional change at 30 minutes and there was significant dimensional changes at 6 hours. However, the disinfectants were not considered in our study.

Erbe at al.[11] had concluded that the irreversible hydrocolloid impression materials stored in humidor (low moisture) must be poured within four hours and if wrapped in wet paper towel (high moisture), impression should be poured within two hours. In our study, the zinc oxide eugenol impression in wet conditions have dimensional change after six hours and cannot be poured. Some of the newer products of alginate impression material have been found to be dimensional stable after 72 and 120 hours.[2]

Linear dimensional stability was changed to 0.91% at 24 hours for one type of irreversible hydrocolloid and 0.61% for other type at 96 hours with respect to the original measurement.[14]

In another study[15] in low temperature of 4˚C there was no statistical difference from control group in 12, 25 and 45 minutes and significant difference after 60 minutes for irreversible hydrocolloid. And in higher temperature of 23˚C the dimension had significantly changed at 25, 45 and 60 minutes. Storage time has effects on the dimensional stability of zinc oxide eugenol impression paste in dry conditions. However, the change is within acceptable limit of 0.1mm up to 24 hours in our study. In wet condition, the dimensional stability as compared to original measurement was significantly changed at 6, 12, 24 and 36 hours.

Some of the limitations of this study are small sample size, errors in measurement, inherent errors of the instrument. We also have to measure the dimension at different times of the day which resulted in temperature change. The sample preparation and measurement were done in less humid environment which could have affected the dry samples.

Conclusion

Within the limitations of the study, the following conclusions can be drawn.

1. The dimensional change of zinc oxide eugenol impression paste from the original measurement was not significantly seen in 30 minutes, 6 hours, 12 hours and 24 hours in dry condition. There is statistically significant dimensional change at 36 hours in dry condition. Thus, it can be poured up to 24 hours after setting.
2. In wet condition, the dimensional change was seen statistically significant in 6 hours, 12 hours and 24 hours and 36 hours. So, it is not recommended to wrap in wet paper to preserve the zinc oxide eugenol impression.

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