

Comparative study on linear dimensional stability between condensation silicones and addition silicones using the sandwich technique



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Abstract

Purpose: The study refers to the linear dimensional stability of silicone elastomers by comparing silicones with condensation curing and silicones with addition curing.

Materials and Methods: The present research is represented by an "in vitro" study, interested only in the evolution of the dimensional stability of silicone elastomers in terms of the material used. A control model was created made of a hard plastic with which the existing samples were compared. The photographic documentation of each study model was made, in order to later document the differences obtained compared to the control model.

Results: All photos taken were analyzed using a photo analysis software (UTHSCSA ImageTool, version 3.0). The measurement results were recorded in tables and statistically analyzed.

Conclusions: The ideal material in terms of dimensional stability is represented by addition cure silicone.

Keywords: Condensation Silicone, Addition Silicone, ImageToll, Dimensional Stability

INTRODUCTION

The dental imprint within the fixed prosthesis represents the negative copy of the prosthetic field and is part of the first stage in the realization of the treatment plan in order to restore the fixed prosthesis.^{1,2} It must reproduce the preparations of the teeth as accurately as possible, using the most accurate materials for recording the prosthetic field, in order to finally offer the patient the comfort he needs through a prosthetic restoration that is as faithful as possible.^{3,4}

The choice of impression materials is made on the basis of imposed conditions: plasticity, fidelity, elasticity and mechanical strength, dimensional stability, curing time, compatibility with modeling materials.⁵

The impression materials that are used today have undergone considerable changes in terms of properties, but are not yet able to fully meet all the necessary conditions.^{6,7} The ideal material should have adapted mechanical properties in order to withstand stresses from different clinical situations.^{8,9}

In order to obtain the most accurate replica, it is necessary that the impressions be cast in the shortest possible time, according to the manufacturers' recommendations, in order to be able to carry out the next prosthetic restoration as accurately as possible.⁵

Aim and objectives

This paper refers to the realization of an "in vitro" study that is based on the use of two types of impression materials, which are part of the category of synthetic elastomers. These are represented by silicone elastomers: condensation silicones and addition silicones (polyvinyl siloxane).

The scientific objectives of the study refer to the discovery of current linear dimensional variations specific to synthetic elastomers within 24 hours from the first manipulation of the material to the time of casting the models. The results obtained will be recorded in terms of materials used.

MATERIAL AND METHODS

The present study is based on the use of a control model from Frasaco that simulates a clinical situation similar to that of the oral cavity. The model used is considered to be the control model because with it the samples resulting from the impressions will be compared, at the level of which four reference grooves were made.

The impression of the model is made using a standard metal impression spoon, inside which the materials used will be inserted. These grooves aim to measure the distance between them by means of six reference lines to which the changes occurred after the impression will be observed.

Materials used were represented by two products: a silicone with condensation curing - Zeta Plus L (Zhermack®) and two types of materials represented by silicones with addition curing - Elite HD + (Zhermack®) and Variotime (Heraeus Kulzer®).

With the help of the three products, the control model was moulded using the sandwich technique - 1 single time, making 3 recordings for each. In the end, the mouldings resulted in 9 impressions.

Given the purpose of the study, we chose the casting time to be 24 hours after the moulds were made. The decision was based on the comparison of the materials used, finally reaching the conclusion related to the choice of the ideal material in terms of dimensional stability.

RESULTS

To investigate all 9 resulting photos, it was necessary to use a photo analysis software (UTHSCSA ImageTool, version 3.0). The photos were calibrated, taking into account the fact that the image has the Pixel as a unit of measurement, and the imprints were measured in millimeters, conversion being necessary to avoid measurement errors and to obtain data as accurate as possible for the study.

Thus, by joining the 4 holes at the level of the occlusal surface resulted 6 lines that were numbered with letters (from A to F) each line having two correspondents. The distances between the holes were highlighted as follows: Line A: distance from 4.5. at 4.7., Line B: distance from 4.7. at 3.7., Line C: distance from 3.7. at 3.5., Line D: distance from 3.5. at 4.5., Line E: distance from 4.5. at 3.7., Line F: distance from 3.5. at 4.7. (figure 1).

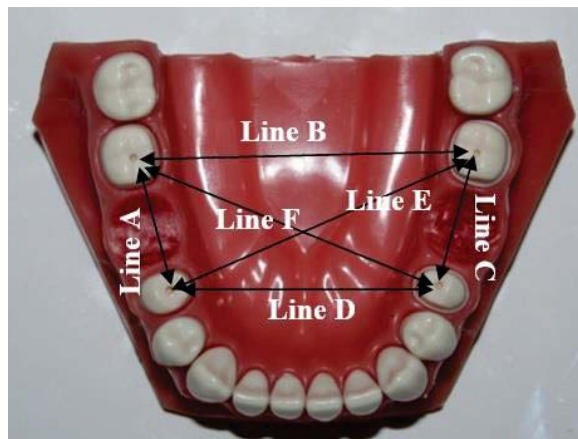


Figure 1. Control model with the four holes at the occlusal surface.
Distances between holes marked by reference lines (A-F)

The reference values in mm were established on the control model, and then the 9 models were analyzed. Values measured at the level of the six lines: Line A - 19,92 mm, Line B - 50,69 mm, Line C - 20,10 mm, Line D - 39,46 mm, Line E - 49,78 mm, Line F - 48,78 mm.

All measurements resulted in a series of information that was systematized by establishing the Median ($\bar{X}$) and the Standard Deviation (DS), thus having an overview of changes in the linear dimensional stability of silicone elastomers. (table 1).

Table 1. Analysis of the models made by establishing the Median ($\bar{X}$) and the Standard Deviation (DS)

Reference lines	Imprint material					
	Zeta Plus L		Elite HD+		Variotime	
	$\bar{X}$	DS	$\bar{X}$	DS	$\bar{X}$	DS
Line A 4.5. → 4.7	19,57 mm (0,35 mm)	0,175	19,71 mm (0,21 mm)	0,105	19,76 mm (0,16 mm)	0,008
Line B 4.7. → 3.7.	50,29 mm (0,40 mm)	0,200	50,42 mm (0,27 mm)	0,135	50,62 mm (0,07 mm)	0,035
Line C 3.7. → 3.5	19,61 mm (0,49 mm)	0,245	20,02 mm (0,08 mm)	0,004	19,73 mm (0,37 mm)	0,185
Line D 3.5. → 4.5	39,11 mm (0,35 mm)	0,175	39,26 mm (0,20 mm)	0,100	39,33 mm (0,13 mm)	0,065
Line E 4.5. → 3.7.	49,57 mm (0,21 mm)	0,105	49,64 mm (0,14 mm)	0,070	49,34 mm (0,44 mm)	0,220
Line F 3.5. → 4.7.	48,38 mm (0,40 mm)	0,200	48,60 mm (0,18 mm)	0,090	48,69 mm (0,09 mm)	0,045

DISCUSSIONS

Data from the literature refer to two methods of assessing dimensional stability: one is based on impression analysis and the other on cast models after the impressions have been registered.⁴

In our study all the materials achieved the dimensional stability within 24 hours after impression.

In the study conducted by Gonçalves¹⁰, a study based on data from the literature, it was concluded that condensation silicones are the ones that record the most errors in terms of dimensional stability. Regardless of the time when the impression is to be cast, they are not stable, recommending that the casting not be made later than 30 minutes after the impression so that the future prosthetic restoration is adapted as correctly as possible.

In our study, even if the casting was chosen 24 hours after the impression, the significant differences between the values obtained compared to the values of the control model determined us to reach the same conclusion reached by Gonçalves¹⁰, which is why we do not recommend using this material for fixed prosthetic works especially the overall ones.

Vitti¹¹ in his 2011 study concluded that in general, addition polyvinyl siloxane are the most dimensionally stable. They do not show significant differences either between themselves and with respect to the data recorded at the level of the prosthetic field. These small differences can also occur after packaging the products, thus referring to their composition. In our study we reached the same conclusion regarding the use of addition cure silicones in the impression of the prosthetic field.

Given that the control model was represented by the edentation of the lower first molars 3.6 and 4.6. respectively, the study was oriented in the direction of analyzing the distances between several points. There were 6 baselines based on which all results were recorded.

Following these results, the values obtained from each material in which the Average (X̄) of the values obtained and the Standard Deviation (DS) were established, were interpreted. Thus, we concluded that: the lowest value at the level of dental impressions was 0.07 mm (X̄) and 0.035 DS, the values belonging to the polyvinyl siloxanes batch represented by Variotime (Heraeus Kulzer®) material, whereas highest values for the condensation silicones - Zeta Plus L (Zhermack®) were recorded being 0.49 mm (X̄) and 0.245 DS.

CONCLUSIONS

Following the study, we concluded that : the least indicated material to be used in terms of dimensional stability in fixed prosthetics is with condensation silicones, and the ideal material in terms of dimensional stability is polyvinyl siloxanes.

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