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| ORIGINAL

Linear dimensional change of edentulous models made of high-density laboratory silicones at different storage times

Alteração dimensional linear de modelos edêntulos fabricados com silicones laboratoriais de alta densidade em diferentes tempos de armazenagem

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ABSTRACT

Objective: To evaluate the dimensional change of edentulous models made of high density laboratory silicones at different storage times. **Methods**: A metallic master model simulating an edentulous maxilla was used. The model had projections of 1.8 cm located in the regions of canines (A and B) and molars (C and D) allowing the linear measurement of distances AB, BC, CD, DA, AC and BD. A laboratory silicone mold was made for duplication of master model in the following materials (n = 10): G1: Zetalabor 85, G2: Titanium 95, G3: Platinum 95 and G4: Gypsum type III (control). The samples were photographed and measured using a software (Image J) at times T1 (baseline) and T2 (after one week of models fabrication). The data were statistically analyzed using Kruskal- Wallis and Dun non-parametric tests (α = 0.05). **Results**: The storage time influenced the behavior of the materials evaluated. All groups presented dimensional changes in both times and the group Tit95 presented the best results. Only Zet85 group showed a different behavior related to the region of the model. **Conclusion**: The high density laboratory silicones showed satisfactory results when compared to the gypsum group. Tit95 was the most stable material and it can be recommended as an edentulous model for total protheses.

Indexing terms: Silicone elastomers. Dimensional measurement accuracy. Complete denture.

RESUMO

Objetivo*: Avaliar a alteração dimensional de modelos edêntulos fabricados em silicone laboratorial de alta densidade em diferentes tempos de armazenagem.* ***Métodos****: Um modelo mestre metálico simulando uma maxila edêntula foi utilizado. O modelo possuía*

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projeções oclusais de 1,8 cm localizadas nas regiões de caninos (A e B) e molares (C e D), permitindo a mensuração das distâncias lineares AB, BC, CD, DA, AC e BD. Um molde foi fabricado em silicone laboratorial para duplicação do modelo mestre com os seguintes materiais (n = 10): G1: Zetalabor 85, G2: Titanium 95, G3: Platinum 95 e G4: Gesso tipo III (controle). As amostras foram fotografadas e mensuradas com auxílio de um software (Image J) nos tempos T1 (baseline) e T2 (após uma semana de confecção). Os dados obtidos foram avaliados estatisticamente utilizando os testes não paramétricos de Kruskal- Wallis e Dunn (α = 0.05). ***Resultados****: O tempo de armazenagem influenciou o comportamento dos materiais avaliados. Todos os grupos apresentaram alterações dimensionais em ambos os temos de avaliação e o G2 apresentou os melhores resultados. Apenas o grupo G1 mostrou alteração dimensional dependente da região mensurada.* ***Conclusão****: Silicones laboratoriais de alta densidade mostraram resultados satisfatórias de alteração dimensional quando comparados ao gesso tipo III. O material Titanium 95foi o mais estável e pode ser recomendado como alternativa para a confecção de modelos edêntulos.*

Termos de indexação*: Elastômeros de silicone. Precisão da medição dimensional. Prótese total.*

INTRODUCTION

Edentulism is a matter of public health and research developed in order to improve techniques and materials, seeking the quality of total dentures are of great relevance and scientific appeal [1,2]. Several authors attribute to the materials used in the manufacture of prostheses the causes of problems [3] such as, lack of adaptation, increased vertical dimension occlusion, porosity and lack of resistance. Factors such as, expansion of the gypsum model due to tension caused by crystallization nuclei [4], imprint of uneven surfaces at the base of the prosthesis and acrylic resin contraction [5] have been pointed out as the main factors responsible for dental movements during the inclusion and polymerization processes of dentures.

According to Parvizi et al. [6], among the main effects caused by the contraction of polymerization of the acrylic resin, the following stands out: the distortion of the prosthesis in the palate region; which results in the lack of precision in adapting the prosthesis to the tissues and changes the position of the teeth in the arch superior, which is very important for clinical success. Thus, studies have been developed in order to minimize such problems as the development of new techniques [7,8].

The use of silicones in prothetic laboratories is increasing because of its insertion properties in various procedures. The material exibit improved accuracy comparesd to direct optical scanners in the impression of full archs [9]. It is also used as an intermediary material between gypsum model and the base of the acrylic resin prosthesis [10] to avoid the dispersion of the resin inside the porosities characteristic of a gypsum model which promots the demoulding succinctly and facilitating the polishing of the prosthesis. But literature lacks of evidence regarding technique or material with the best advantages for making complete dentures and removable partial dentures [8].

The applicability of the laboratory silicone and the use of this material for the preparation of the work model for total dentures could be considered, since it could significantly improve some aspects in the methodology of laboratory processing of total dentures such as, reduction of working time and obtaining a cleaner and easier execution; and possibility of dentures with minor dimensional changes [9]. It is known that a dimensional change is a variable present in the process of total prosthesis confection, regardless of the laboratory processing performed [11].

Therefore, the objective of this study was to evaluate the dimensional alteration of models made in high density laboratory silicones, in different storage times, compared to the conventional technique using type III gypsum models. The alternative hypothesis tested was that the samples made with the high-density laboratory silicone would present greater dimensional stability than the control group (gypsum type III).

METHODS

Preparation of samples

For the study, a metallic model (master model) simulating an edentulous maxilla with four markings (A, B, C, and D) was used as the basis for the analysis (figure 1). The model had projections of 1.8 cm located in the regions of canines and molars that, when joined together, allow the linear measurement of distances AB, BC, CD, DA, AC and BD to verify the dimensional changes. Each projection has an ”X” marking, in which the intersection of the two lines was the point of measurement of the linear distances.

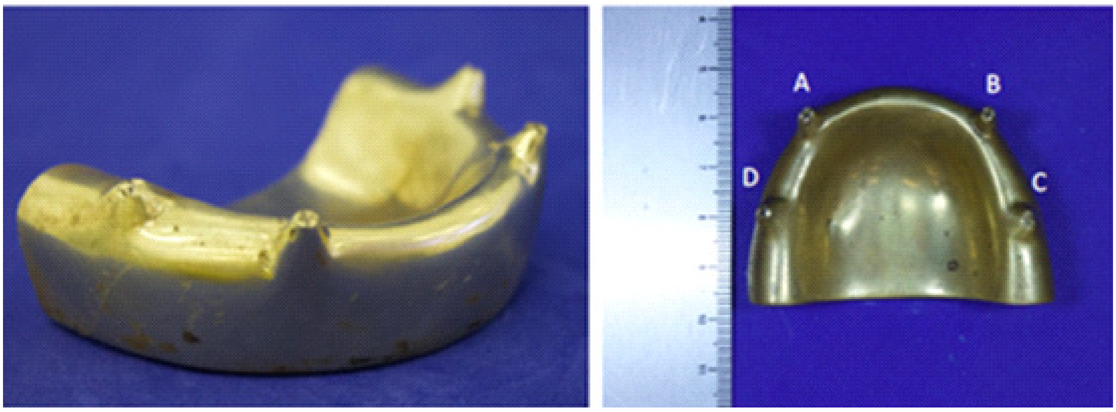

Figure 1. Master Model with Markings: A, B, C and D.

From this model, four duplication silicones (Silicone Master Talmax, Curitiba, PR, Brazil), were made, one for each study group (n = 10); Group 1: Zetalabor 85 (laboratory condensation silicone, Zhermack, Badia Polesine – RO, Italy); Group 2: Titaniu 95 (laboratory condensation silicone, Zhermack, Badia Polesine, RO, Italy); Group 3: Platinum 95 (laboratory addition silicone, Zhermack, Badia Polesine -RO, Italy) and Group 4: Gypsum (control group) edra type III P (plaster Herodent, Vigodent -COLTENE, Rio de Janeiro, Brazil).

For the preparation of the condensation and addition models, three silicone portions were provided and handled according to the manufacturer’s recommendations at room temperature of 23 + 2°C. Each material was inserted into the mold in small portions and under moderate digital pressure within the working time of 2 minutes, as recommended by the manufacturer, and after 6 min the template was separated.

For the construction of the Gypsum Type III models, water and powder (30ml/100g) were provided according to the manufacturer’s recommendation, manually sprayed for 1 minute and slowly poured into the silicone mold with the aid of a plaster vibrator (Essence Dental VH, Araraquara, Sao Paulo, Brazil). The template separation was performed after 60 min.

For all groups, 3mm plate acetate pre-prepared with two holes to be fitted into the side pins of the muffle, and it was pressed onto the extruded material in the mold until it touched the muffle, thus ensuring a standard height base for all models (figure 2). In the center of PLA acetate was set button, which printed a concave mark in the centre of the base of the model to standardize the positioning of all models.

Obtaining images and readings

The dimensional alteration of the models was verified by the digital image analysis method. In the first phase, images of the models were obtained, which were supported in a stand with the base standardized for the positioning of the models and its vertical branch attached a camera digital (Canon Eos Rebel T3, Canon USA Inc., Taiwan, China), with lens 18- 55mm (figure 3). Next to the model, a millimeter water slide was positioned for later calibration, analysis and measurements in ImageJ software (Wayne Rasband, National Institutes of Health - USA).

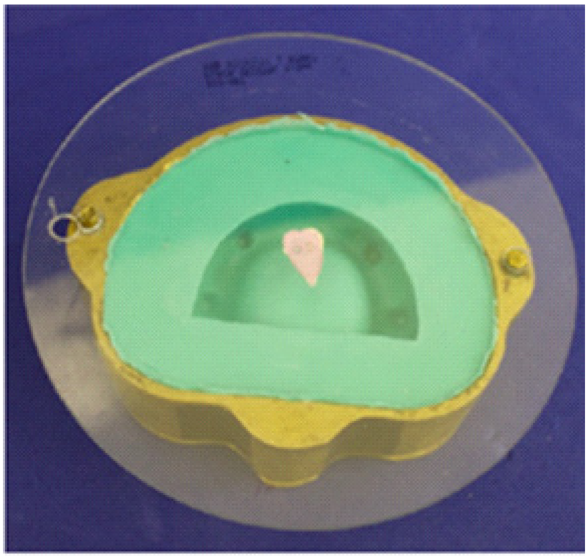

Figure 2. Acetate plate, with button attached to the counter muffle.

Figure 3. Model, camera and millimeter ruler positioned on the frame.

The models were photographed in two different times: T1; immediately after the making of the models and T2; after 7 days of manufacture during the storage period. The models were kept exposed in an environment with controlled temperature and humidity. The obtained images were submitted to measurements of linear distances between the A, B, C and D points. Thus, the absolute measures AB, BC, CD, DA, AC and BD were measured using ImageJ software. Each model was read 6 times, cyclically, on alternate days so that there was no reading of the operative r, thus generating 360 measurements in each evaluated group (zet85; tit95; plat95; gypsum) and 36 measurements in the master model.

Subsequently, data were grouped into three categories: latero-lateral, measurements of distances AB and CD; measurement of anteroposterior distances AD and BC; and cross-sectional measurements of AC and BD distances. The percentage of dimensional change that each measurement presented when comparing the measurements of the master model was obtained. The data were analyzed statistically (Bioestat software 5.3 - Institute Mamiraua, Belem, Para, Brazil) at the significant level of α = 0.05 and Kruskal -Wallis and Dunn test was used.

RESULTS

In Zet85 group, the time did not influence the dimensional changes. However, the change in anteroposterior distance showed the greatest change in both the T1 and the T2. For the Tit95 group, time and regions did not influence dimensional changes (table 1 and table 2).

In relation to the samples from the Plat95 group, it can be observed that the time exerted the effect, being the major alterations observed in T1. The regions did not influence the dimensional changes in both T1 and T2.

In the control group (Gypsum Type III), the time influenced dimensional changes in all regions, and alterations were greater in T2 than in T1.

Mean and standard deviations of the dimensional change values of all groups according to the materials and time of evaluation are described in table 3.

Table 1. Measurements of dimensional change values (%) according to different regions and materials in time 1.

	Zet85	Tit95	Plat95	Plaster
Lat/Lat	0,009 Bb	0,007 Ab	0,013 Aa	0,006 Ab
Ant/Post	0,016 Aa	0,007 Ab	0,013 Aa	0,006 Ab
Transv	0,010 Ba	0,007 Ab	0,014 Aa	0,006 Ab

Note: Values followed by vertical upper and lower case letters denote statistical difference (Kruskal-Wallis and Dunn, $p < 0.05$).

Table 2. Measurements of dimensional change values (%) according to different regions and materials in Time 2.

	Zet85	Tit95	Plat95	Plaster
Lat/Lat	0,008 Bab	0,006 Ab	0,006 Ab	0,012 Aa
Ant/Post	0,021 Aa	0,009 Ab	0,007 Ab	0,012 Ab
Transv	0,010 Bab	0,006 Abc	0,004 Ac	0,012 Aa

Note: Values followed by vertical upper and lower case letters denote statistical difference (Kruskal-Wallis and Dunn, $p < 0.05$).

Table 3. Mean and standard deviations of the dimensional change values (%), according to the materials and time of evaluation.

	Zet85		Tit95		Plat95		Plaster	
	T1	T2	T1	T2	T1	T2	T1	T2
Mean	0,011a	0.013a	0.007b	0.008b	0.013a	0.007b	0.006b	0.013a
SD	0.007	0.008	0.005	0.006	0.006	0.005	0.004	0.018

Note: Values followed by upper and lower case horizontal letters (Kruskal- Wallis and Dunn, α=0.05).

DISCUSSION

The null hypothesis presented in this study is rejected since the models made of high density silicon laboratory showed greater dimensional stability than the control group. The time did not influence the dimensional changes in relation to the Zet85 and Tit95 groups, only in the samples of the Plat95 group. The alterations were greater in T1 than in T2, where the group Plat95 presented the lowest percentage of dimensional change in relation to the master model when compared to other groups. This result was demonstrated in all regions analyzed.

Considering that the material of the Plat95 group is a addition silicone, and based on the works found in the literature, it was expected that it did not present such influence with respect to variable time [9]. However, this change was below the maximum recommended by the Specification at the 19th meeting of the ADA (1977), which recommends a maximum contraction of 0.5 to 1.0% after 24h, thus being within the expected normality for such material.

As for the control group, time influenced dimensional changes in all regions, and changes were greater in T2, confirming crystalline theory and pre-expansion [4]. This result corroborates with the findings by Salloum [6] who obtained a smaller change in the vertical dimension of total prosthetic occlusion when using high-expansion gypsum type V as a covering material. Furthermore, our result is in agreement with the study of Gennari et al. [12] who observed that the greatest changes in the positioning of artificial teeth were exhibited in the group with barrier type IV gypsum (Durone) when compared to silicone (Labor Mass), especially during the filling of the muffle and after the deflating.

The ES region was not influenced amendments scales is at T1 and T2 for Tit95 groups Plat95 and gypsum, however, exerted influences were in samples of Zet85 group, with the greatest change occurred in region before / After, both in T1 and T2.

The Tit95 group behaved similarly to the control group (gypsum) in relation to the dimensional change in all the regions in the T1, although in T2 it had a superior behavior, demonstrating a smaller degree of dimensional alteration in relation to the master model, which behaved similarly to Plat95 in T2.

Given these results, it is important to analyze the impact of the cost of the procedure. Therefore, considering the fact that each model would spend 100g of the laboratory silicone, it could be stated that when incorporating this new technique at the market price for a total prosthesis, the technician would have to act close to 1.3 % in its price, for the models in Zetalabor 85; 1.5% for Titanium 95 models; and 7% for Platinum 95 models. Another alternative, which could be tested in a future study, is to obtain a mixed model, using gypsum and silicon, in order to obtain the efficacy of the material with the reduction of cost.

Analyzing the results of this technique which reduces fracture resulting from deflasking procedures, minimizes stress generated by the contraction of the resin, and also facilitates the procedures and polish the pro t ESCO, it is believed that the impact on the cost of the specimen can be perfectly managed by the laboratory and/or the dental surgeon. In this view, it can be noted that the material of Tit95 group recorded the best results with regard to dimensional stability in both times tested within the ADA specifications and is more stable than the control group. Therefore, it is recommended to use this material for the production of work models in making of total protheses.

CONCLUSION

The high-density laboratory silicones showed satisfactory results when compared to the Gypsm group (control). The storage time only influenced Plat95 and Gypsm groups for all evaluated regions. Moreover, Tit95 group was the most stable material in the both times tested, regardless of the region analyzed, and it can be recommended as edentulous models for total protheses.

Collaborators

APLG Damasceno, substantial contributions to the conception or design of the work; acquisition, analysis, or interpretation of data for the work; drafting the work; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. PN Castro, acquisition, analysis, or interpretation of data for the work; revising the manuscript critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that

questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. LMV Silva, acquisition, analysis, or interpretation of data for the work; revising the manuscript critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. K Baroudi, substantial contributions to the conception or design of the work; revising the manuscript critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. M Amaral, acquisition, analysis, or interpretation of data for the work; revising the manuscript critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. LR Silva-Concílio, substantial contributions to the conception or design of the work; drafting the work; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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