EVALUATION OF DIMENSIONAL CHANGE AND DETAIL REPRODUCTION IN SILICONES FOR FACIAL PROSTHESES

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ABSTRACT

The aim of this study was to evaluate the dimensional stability and detail reproduction of two silicones used for facial prosthesis, under the influence of chemical disinfection and storage time. Twenty-eight test specimens were obtained, half made of Silastic MDX 4-4210 silicone, and the other half of Silastic 732 RTV silicone. The test specimens were divided into 4 groups: Silastic 732 RTV and Silastic MDX 4-4210, with disinfection 3 times a week with Efferdent and without disinfection. Dimensional change was analyzed using an electronic comparison microscope and detail reproduction was observed under a stereo microscope, immediately and 2 months after the test specimens were made. Once the results were obtained, an analisis of variance (ANOVA) was applied, followed by the Tukey's Test with 1% confidence. The storage time factor had a statistical influence on dimensional stability: Silastic MDX 4-4210 had less contraction than Silastic 732 RTV. Chemical disinfection did not significantly alter the dimensional stability of the materials used. Regarding detail reproduction, no alteration of values was observed in any of the materials analyzed, regardless of storage period or disinfection.

Key words: *oral and maxillofacial prosthesis, dimensional change, chemical disinfection, detail reproduction.*

EVALUACIÓN DE LA ALTERACIÓN DIMENSIONAL Y MANTENIMIENTO DE DETALLES EN SILICONAS PARA PRÓTESIS FACIALES

RESUMEN

El objetivo de este estudio fue evaluar la estabilidad dimensional y el mantenimiento de detalles, de dos siliconas para uso en prótesis facial, bajo la influencia de la desinfección química y del tiempo de almacenamiento. Fueron obtenidos 28 probetas, una mitad con silicona Silastic MDX 4-4210 y, la otra, con silicona Silastic 732 RTV. Las probetas fueron divididas en 4 grupos: Silastic 732 RTV y Silastic MDX 4-4210 con desinfección de 3 veces por semana con efferdent y sin desinfección. El análisis de alteración dimensional fue hecho en un microscopio electrónico comparador y el mantenimiento de detalles fue observado en una lupa estereoscópica, inmediatamente y 2 meses después de la confección de los cuerpos de prueba. Después de la obtención de los resultados, fue aplicado análisis de variancia (ANOVA), seguido del Test de Tukey con confiabilidad de 1%. El factor tiempo del almacenaje influenció estadísticamente en la estabilidad dimensional: Silastic MDX 4-4210 presentó una menor contracción que Silastic 732 RTV. La desinfección química no alteró significativamente la estabilidad dimensional en los materiales utilizados. Con respecto al mantenimiento de detalles, no se observó alteración de los valores en ninguno de los materiales analizados independientemente del período de almacenaje o desinfección.

Palabras clave: *prótesis bucomaxilofacial, alteración dimensional, desinfección química, mantenimiento de detalles.*

INTRODUCTION

Maxillofacial prostheses are used for rehabilitating patients suffering from acquired or congenital disfiguration. Elastomeric materials such as poly (siloxane) were introduced in maxillofacial technology during the nineteen-sixties and are now the materials of choice[1,2].

There are countless problems with current materials, a noticeable reduction of the tear strength, reduction in color stability, and wettability, which may cause abrasion of the tissues surrounding the prosthesis[1-11].

It is important to have materials with adequate tension and hardness properties. Tear strength should be high enough so that the very thin edges of the prosthesis can be reproduced to join the surrounding tissues. The material should not be too rigid, and ideally it should be as similar as possible to skin.

Silicones for facial use have excellent dimensional stability[12]. It is believed that during polymerization of this type of silicone, a volatile by-product is formed – acetic acid for Silastic 732 RTV and formaldehyde for MDX4-4210[6].

The aim of this study was to verify the dimensional alteration and detail reproduction of two silicones used in facial prostheses, under the influence of chemical disinfection and storage time at room temperature.

MATERIALS AND METHODS

Two types of silicone were used to make the test specimens: Silastic MDX 4-4210 (Dow Corning Corporation, USA) and Silastic 732 RTV (Dow Corning do Brasil, SP, Brazil).

Test specimens were prepared according to ADA specification nº 19[8] for non-aqueous elastomeric impression materials, to test dimensional stability and detail reproduction. A cylindrical metal block and a ring-shaped metal mold were used. The ring-shaped metal mold (B) was adapted to the upper part of the cylindrical metal block (A), to leave a space where the silicone was placed. The Silastic 732 RTV silicone remained confined inside the block, with the outer surface exposed to the environment for 24 hours, to release the acetic acid. According to the manufacturer, silicone stabilizes 24 hours after the polymerization process begins. Silastic MDX 4-4210 was confined inside the block with the outer surface exposed to the environment for 3 days, because according the manufacturer's recommendations, in 24 hours it is partially cured, which allows manipulation, but the final curing takes place after about 3 days, releasing formaldehyde. After this time, each test specimen was carefully removed from the metal block, to avoid any distortion. Thus, 28 test specimens were obtained, which were divided into 4 groups, with seven in each group: group 1, Silastic MDX 4-4210 disinfected with effervescent tablets; group 2, Silastic MDX 4-4210 without disinfection; group 3, Silastic 732 RTV disinfected with effervescent tablets; group 4, Silastic 732 RTV without disinfection.

Dimensional stability was analyzed using a Carl Zeiss comparison microscope (Germany) with a resolution of 0.001 millimeters. The following formula was applied to calculate the dimensional change of the materials tested [4, 8]:

$$\text{Dimensional change (\%)} = \frac{(B - A)}{A} * 100$$

A= *original distance of the block between edges C and D = 25 mm.*

B= *distance between edges C' and D' in the test specimens at the original time and after 60 days.*

For detail reproduction, the test specimens were checked for angle accuracy in the three grooves reproduced on them from the metal block (A), 20 µm, 50 µm and 75 µm wide. Detail reproduction was observed under an Olympus Tokyo stereo microscope with low-angle illumination and 13x magnification. To classify the accuracy of detail reproduction in the test specimens, the scores described below were used [4,8]:

x- no groove reproduction;
0- full reproduction of two of the three grooves;
1- full reproduction of the 3 grooves, without accurate angles
2- full reproduction of the 3 grooves, with accurate angles.

All the test specimens were stored in an uncovered plastic container on a table in the lab at non-controlled temperature for 60 days, under artificial lighting, without direct incidence of natural lighting. These conditions sought to mimic the conditions under which these prostheses are kept during their clinical use by patients, i.e. in contact with the environment.

The groups that were disinfected were placed in lukewarm water with an effervescent tablet (Efferdent, Pfizer, USA) for 15 minutes 3 times a week.

After the 60 day disinfection and storage periods, all the readings done during the initial phases for the tests described above were repeated.

Once the results of the dimensional stability test were obtained, analysis of variance (ANOVA) was applied, followed by Tukey's test with 1% confidence. For the analysis of detail reproduction, the scores recommended by Goiato et al.[4] were used to compare the accuracy of the angles in the grooves reproduced by the silicone.

RESULTS

Results are summarized in tables 1 to 4.

DISCUSSION

The data in Table 1 show that Silastic 732 RTV and MDX 4-4210 silicones have polymerization negative linear dimensional alteration (contraction) when compared to dimensions C and D of the metal block (25 mm), and there are significant statistical differences between them. It is believed that all

TABLE 1. General comparison of the mean values and standard deviation of dimensional stability (%) of the silicones.

	MDX	Silastic	Statistical Difference
Mean	0.08% (0.001)	0.136% (0.003)	Sig

Tukey's Test 1% confidence

TABLE 2. Mean values of dimensional stability (%) and standard deviation under the influence of chemical disinfection of silicones.

	With disinfection	Without disinfection	Statistical Difference
Mean	0.1% (0.001)	0.1% ((0.003)	Not Sig

Tukey's Test 1% confidence.

TABLE 3. Mean values for dimensional stability (%) and standard deviation under the influence of storage period.

	Initial	Final	Statistical Difference
Mean	0.076% (0.005)	0.124% (0.004)	Sig

Tukey's Test 1% confidence.

TABLE 4. Scores of silicones (ADA specification Nº 19) for detail reproduction under the influence of disinfection and storage period.

	Without Disinfection	With Disinfection	Initial	Final
MDX	2	2	2	2
Silastic	2	2	2	2

elastomers contract during polymerization. This can be explained in Table 3 where there was statistically significant change between the initial and final values for the storage period. For both silicones, the values after the storage period, for groups with or without disinfection, all show good dimensional stability.

The finding that silicones for facial use have excellent dimensional stability agrees with the results of Yu & Koran[12]. It is believed that during the polymerization of this type of silicone a volatile by-product is formed – acetic acid for Silastic 732 RTV and formaldehyde for MDX4-4210. Its subsequent evaporation is probably responsible for contraction, as occurs in other types of silicones after polymerization (continuous or residual polymerization)[6].

Although there was contraction in the test specimens of all groups, they are within the recommendation of ADA specification nº19, according to which contraction must not be more than 1% in 24 hours. Yu & Koran[12] evaluated the permanent deformation of four facial silicones (Silastic 382, 399, 4-4210 and 4-4515) before and after 900 hours of accelerated aging and found that all silicones had excellent dimensional stability before and after aging, with permanent deformation of about 0.22% to 0.26%. In the comparison between groups with and without chemical disinfection shown in Table 2, there was a negative dimensional alteration similar to the groups without disinfection, with no significant difference between them. Langenwalter et al.[5] also found that disinfectants did not produce significant linear dimensional alteration on the elastomeric materials tested.

Regarding detail reproduction, the results in Table 4 show comparatively that all groups of both silicones reproduced the score level 2 when observed using the Olympus Tokyo stereo microscope with low-angle illumination and 13x magnification, regardless of exposure time to the environment and chemical disinfection. According to the classification used, level 2 means that all test specimens fully reproduced the 3 grooves with accurate angles. These results confirm the observations of several authors[7, 3] who found that silicones (for impression) and facial silicones had excellent detail reproduction capacity, reproducing grooves of up to 20µm wide. Similar results were found by Storer & McCabe[9], and Toh et al.[10], who found that immersion of silicone molds (for impression) in different disinfectants did not alter the details produced by the impression.

CONCLUSION

After analyzing the results we concluded that contraction in Silastic MDX 4-4210 was statistically

significantly less than in Silastic 732 RTV, and that the storage time factor had a statistical influence on the dimensional stability properties, while chemical disinfection did not significantly alter dimensional stability of the test specimens of the materials used. Regarding detail reproduction, there was no alteration of values in either of the materials analyzed, regardless of storage time or disinfection.

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