Accuracy of Two Condensation--Type Light Body Silicones after Setting

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Summary

The aim of the study was to determine which dimensional changes occur in two types of low viscosity condensation-type silicone materials (Xantopren - Bayer, Germany and RTV - Bosnalijek, Sarajevo, BiH), when prepared in different conditions (mixed by hand or mechanically, with and without the addition of 3 drops of water) a different time period after setting.

A total of 56 samples were prepared, 7 samples of each silicone (Xsantopren, RTV) in each examined condition (mixed by hand or mechanically, with or without the addition of 3 drops of water). Specimens were poured into a mould until set. The samples were then removed from the mould and stored at room temperature. Using an optical instrument SIP-414 with a digital microscope, dimensional measurements at different time intervals after setting (2, 4, 8 24 and 48 hours) were made. The referent value was the measure of the mould, which was 24.7 mm.

The examined silicone condensation-type impression materials, mixed by hand or mechanically with or without addition of 3 drops of water, showed continuous contraction. The referent value (mould dimension) was greater than all other values measured 2, 4, 8, 24 and 48 hours after setting. The longer the period of sample storage, the greater the silicone contraction. χ^2 test revealed that mean values measured in this study are significantly smaller than the referent value, depending on the period of the material storage. Contraction was greater than 0.5% after 2 hours of storage, regardless of mixing condition.

The examined silicone condensation-type impression materials showed significant contraction, which increased during the period of storage, no matter how the material was prepared (mechanically mixed, or by hand; with or without addition of water). The results indicate that silicone condensation-type impressions should be poured into hard stone as soon as possible, to preserve the desired accuracy.

Key words: *condensation-type silicones, low viscosity, dimensional changes after setting*

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Introduction

Silicones are rubber impression materials widely used in prosthodontics and other types of reconstructive treatments.

Today, more than 30 chemical industries produce various silicone materials. Their exact composition is the producer's top secret.

Silicones are macromolecular substances with chains composed of Si=O groups and alcil radicals (Methyl, vinil, halogen, hydrogen or alcoksi groups) (1). Two types of silicones are recognised, depending on the chemical reaction during polymerisation, addition and condensation types.

Condensation-type silicones are polydimetilsiloxanes with OH group in terminal position. When mixed with a catalyst (tetrafunctional etilsilicate), it reacts with terminal OH groups of the silicone chain, with separation of an alcohol (evaporates) and other chains entering into chemical reaction until a three-dimensional net is finally formed.

The precision of the impression is a condition sine qua non in prosthodontics. Although silicones are considered to be materials of the greatest accuracy and precision, they are still subjected to some dimensional changes (2-6). Dimensional changes of a silicone impression material depend on its thickness (2, 3), setting time in the mouth (4, 5) and the temperature during setting (6). It has been reported that the period between the time the impression is made and the time the cast is poured is the most important for dimensional changes and imprecision of this material (7-9).

The aim of this study was to observe dimensional changes of two types of low viscosity condensation-type silicone materials (Xantopren and RTV, both light body silicones) after setting, prepared in different conditions: mixed by hand or by a machine, both with and without the addition of 3 drops of water.

Materials and methods

The silicone impression materials (Xantopren - Bayer, Germany and RTV - Bosnalijek, Sarajevo, BiH) - both condensation-type light body silicones, were studied. According to ISO-4823 (10), both materials belong to type III - low viscosity impression silicone materials.

Dimensional changes of these two condensation-type silicones were studied. Samples were constructed in a brass mould according to ISO-4823 (10), divided into 5 parts (Figure 1).

Four groups of samples were made; the first sample group was made by mixing Xantopren and RTV silicones by hand in a dry condition (without adding 3 drops of water) and the second sample group was mixed by hand in a humid condition (three drops of tap water was added). The third sample group was made from the same materials, mechanically mixed in a dry condition and the fourth sample group was also mechanically mixed in a humid conditions (three drops of tap water was added to the catalyst prior to mixing). A total of 56 samples were made, 7 samples of each silicone examined (Xantopren, RTV) in each condition (mechanically mixed or mixed by hand, both by adding and without adding 3 drops of tap water). After the specimens had been mixed (paste + catalyst) they were poured into a brass mould until the material was set. The samples were then removed and left on the horizontal plane until dimensional change measurements were performed.

Dimensional changes of the examined samples were measured using an optical instrument, i.e. the three co-ordinate measuring device SIP-414 (Societe Genevoise d,instruments de physique, Geneva, Switzerland) with a digital microscope with precision of 0.1 micron.

All the samples were measured at different time intervals after setting (after a period of two hours, four hours, eight hours, 24 hours and finally after a period of 48 hours). The referent value "P" was obtained from the measurements of the test block (brass mould without silicone) and its value was 24.7 mm.

Results

Both examined silicone condensation-type impression materials (Xantopren - Bayer, Germany and RTV paste - Bosnalijek, BiH) showed continuous contraction (Table 1 and Table 2). The referent value "P" (mould dimensions) was 24.7 mm and all

other values which were measured 2, 4, 8, 24 and 48 hours later were lower than the referent value (Tables 1 and 2). The longer the period of sample storage, the greater the contraction.

χ^2 test (with 99% level of probability) revealed that the mean values after 48 hours (both for Xantopren silicone material, as well as for RTV silicone material mixed by hand, without adding water), were lower than the referent value (24.7 mm), but were were not significantly different. However, if the value calculated from the coefficient of contiguity $\{C_{max} = (r-1)/r^* \sim 1\}$ was added, then it became clear that the dimensional changes were significantly different (contraction) from the referent value, depending on the period of the material storage (2, 4, 8, 24, 48 hours) (Table 1.).

Silicone condensation-type materials (Xantopren - Bayer, Germany and RTV paste - Bosnalijek, BiH) mixed by hand, with the addition of three drops of tap water, also showed continuous contraction (Table 1). Referent value "P" (mould dimensions) was 24.7 mm, and all other values which were measured 2, 4, 8, 24 and 48 hours later were lower than the referent value (Table 2). χ^2 test (at 99% level of probability) revealed that the mean values after 48 hours storage of Xantopren silicone material, as well as of RTV silicone material, were significantly lower ($p < 0.05$) than the referent value (24.7 mm). Thus the dimensional changes (contraction) were significantly smaller than the referent value, depending on the period of the material storage (2, 4, 8, 24, 48 hours).

The silicone condensation-type impression materials mechanically mixed in dry conditions, without the addition of 3 drops of tap water (Xantopren - Bayer, Germany and RTV paste - Bosnalijek, BiH) showed continuous contraction (Table 2). Referent value "P" (mould dimensions) was 24.7 mm, and all other values which were measured 2, 4, 8, 24 and 48 hours later were lower than the referent value. χ^2 test (at 99% level of probability) revealed that the mean value after 48 hours of storage of Xantopren silicone material, as well as of RTV silicone mate-rial, although lower than the referent value (24.7 mm) were not significantly lower ($p > 0.05$). However, if the value calculated from the coefficient of contigention, which is aproximatly 1 $\{C_{max} = (r-1)/r^* \sim 1\}$ is added, then it is obvious that the dimensional changes (contraction) are significantly smaller depending on the period of the tested material storage (2, 4, 8, 24, 48 hours) (Table 2).

The silicone condensation-type impression materials mechanically mixed with the addition of 3 drops of tap water (Xantopren - Bayer, Germany and RTV paste - Bosnalijek, BiH) showed continuous contraction (Table 2). Referent value "P" (mould dimensions) was 24.7 mm and all other values which were measured 2, 4, 8, 24 and 48 hours later were lower than the referent value. χ^2 test (at 99% level of probability) revealed that the mean values after 48 hours storage of Xantopren silicone material, as well as of RTV silicone material, were significantly lower than the referent value (24.7 mm) ($p < 0.05$). Thus that the measured dimensions (contraction) were significantly smaller than the referent value, depending on the period of the material storage (2, 4, 8, 24, 48 hours).

Figure 2 shows the contraction of the Xantopren-Bayer silicone material (mixed by hand or mechanically, both with and without adding 3 drops of tap water), expressed in percentages at a different time interval after setting (2, 4, 8, 24, 48 hours).

Figure 3 shows the contraction of the RTV - Bosnalijek silicone material (mixed by hand or mechanically, both with or without adding 3 drops of tap water), expressed in percentages at a different time interval after setting (2, 4, 8, 24, 48 hours).

Discussion

Dimensional changes of the two types of silicone condensation-type impression materials examined (Xantopren and RTV) mixed by hand or mechanically, both with and without addition of 3 drops of tap water) were similar. Dimensional changes (contraction) were greater, the longer the period of the material storage after setting.

Dimensional changes according to ISO-4823 for all type III silicone materials are up to 0.35% (10) and according to the results obtained by Phillips (2) dimensional changes range from 0.0% to 0.5%. The results obtained in this study showed greater dimensional changes than ISO-4823, or those found by Phillip's. When the material was mixed by hand

without adding 3 drops of tap water, contraction of Xantopren was 0.59% after 2 hours and 0.69% after 48 hours, while contraction of RTV was 0.52% after 2 hours and 0.68% after 48 hours. When the material was mixed mechanically without adding 3 drops of water, contraction of Xantopren was 0.48% after 2 hours and 0.58% after 48 hours, while contraction of RTV was 0.65% after 2 hours and 0.9% after 48 hours. When the material was mixed by hand with the addition of 3 drops of water, contraction of Xantopren was 0.59% after 2 hours and 0.79% after 48 hours, while contraction of RTV was 0.83% after 2 hours and 1.4% after 48 hours.

The dimensional changes measured in this study indicate that the impression should be poured as soon as possible after being removed from the mouth.

The results of this study corroborate the results of Kempler et al. (11), who observed that contraction of the impression silicone material (both of addition and condensation type) was too large after two hours to be tolerant and they recommended pouring the silicone impression into hard stone within 30 minutes. Our results are also in agreement with the results of other authors: McCabe (12), Marcinak (13), Braden (14), Oda (15) and Eames et al. (16, 17).

Welker et al. (18) also demonstrated contraction of the silicone materials, measuring the weight of the material after 24 hours and 24 days, with a resultant decrease in weight of 2.8% and 7.5%, respectively.

Tjan (19) obtained no difference between mechanical mixing or mixing by hand of any silicones with a catalyst, which is also in agreement with the results obtained in this study, although it had been proved in other studies that air bubbles developed during mixing can influence the final quality of the material and the adhesive power between high body and low body silicones (20-22).

Conclusion

According to the results obtained in this study, the contraction of the examined silicone materials exceeded 0.5% after a period of 2 hours, and therefore it is recommended that the impressions from these materials should be poured as soon as possible.