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Color Stability Comparison of Silicone Facial Prostheses Following Disinfection

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Abstract

Purpose: The purpose of this study was to evaluate the color stability of two silicones for use in facial prostheses, under the influence of chemical disinfection and storage time.
Materials and Methods: Twenty-eight specimens were obtained half made from Silastic MDX 4-4210 silicone and the other half from Silastic 732 RTV silicone. The specimens were divided into four groups: Silastic 732 RTV and MDX 4-4210 with disinfection three times a week with Efferdent and Sliastic 732 RTV and MDX 4-4210 disinfected with neutral soap. Color stability was analyzed by spectrophotometry, immediately and 2 months after making the specimens. After obtaining the results, ANOVA and Tukey test with 1% reliability were used for statistical analysis.
Results: Statistical differences between mean color values were observed. Disinfection with Efferdent did not statistically influence the mean color values.
Conclusion: The factors of storage time and disinfection statistically influenced color stability; disinfection acts as a bleaching agent in silicone materials.

Despite advances in plastic surgery, there will always be a need for maxillofacial prostheses for cancer and trauma patients.[1] Silicone elastomers are the material of choice because of their chemical inertness, strength, durability, and ease of manipulation;[2] however, silicone elastomers and pigments exhibit color change over time.[3] The limited lifetime of facial prostheses is the result of degradation of the elastomer and color instability. Deterioration may be caused by many factors, including environmental exposure and changes in humidity.[4]

Maxillofacial prosthetic treatment allows many patients with orofacial defects to return to an active role in public.[5] For this reason, the manufacture of maxillofacial prostheses is often carried out while the patient still presents an unhealed surgical injury, increasing the risk of infection. As such, the use of a disinfecting agent for the cleaning of facial prostheses is of utmost importance to combat the accumulation of resistant bacteria on these types of prostheses. Gornitsky et al[6] reported that alkaline peroxides significantly reduce the number of microorganisms in the prostheses of hospitalized patients, who are often unable to clean their prostheses adequately. Reports are still scarce regarding the evaluation of the efficiency of alkaline peroxide-based disinfecting agents and their influence on the stability of the color of facial silicones.

The wear time for facial prostheses averages from 3 months to 1 year. Deterioration is also caused by environmental exposure to ultraviolet (UV) light, air pollution, changes in humidity, and temperature,[7-10] and the daily handling and cleaning of the prostheses by the patient.

Surveys have reported color fading as the most frequent reason patients give for disliking their prostheses. Objective investigations of color stability in facial elastomers have used artificial light sources, artificial weathering chambers, and reflection spectrophotometry.[11-13]

Due to these considerations, this investigation aimed to verify the color stability of two silicones for use in facial prostheses, under the influence of disinfection and storage time.

Materials and methods

Silastic MDX 4-4210 (Dow Corning Corporation, Midland, MI) and Silastic 732 RTV (Dow Corning do Brasil Ltda., Hortolândia, SP, Brazil) were used for manufacturing the specimens.

To obtain the specimens, a metallic cylindrical matrix (3-mm high, 30-mm diameter) was used, together with a ring-shaped metallic frame. The Silastic 732 RTV silicone was confined inside the matrix with the external surface exposed to the environment for 24 hours because, according to the manufacturer, the release of acetic acid from this silicone is stabilized 24 hours after the beginning of the polymerization process. The Silastic MDX 4-4210 material was confined inside the matrix with the external surface exposed to the environment for 3 days because, according to the manufacturer, the material is partially cured after 24 hours, allowing its handling. Final cure following the release of formaldehyde occurs within approximately 3 days.

After this period, each specimen was carefully separated from the metallic matrix, in order to avoid distortions. Thus, 28 specimens were obtained and divided into four groups, with seven specimens for each group: Group 1—Silastic MDX 4-4210 disinfected with Efferdent effervescent tablets (Pfizer Consumer Healthcare, Morris Plains, NJ); Group 2—Silastic MDX 4-4210 disinfected with neutral soap (Johnson & Johnson, Langhorne, PA); Group 3—Silastic 732 RTV disinfected with Efferdent effervescent tablets; Group 4—Silastic 732 RTV disinfected with neutral soap (Johnson & Johnson Comécio e Distribuição Ltda, São Paulo).

The color stability test was performed with a Visible UV Reflectance Espectrophotometer**,** Model UV-2450 (Shimadzu, Kyoto, Japan), and color data were computed according to the CIELAB L*a*b* method (Version 1.2KA, MacBeth Optiview, Newburgh, NY), based on the CIE chromaticity diagram 1931 and source A.[14] The values of L^*, a^*, and b^* were entered in a spreadsheet (Microsoft Excel, Redmond, WA) for calculation of ΔE^* as follows: $\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$, where ΔL^*, Δa^*, and Δb^* are changes in L^*, a^*, and b^* between the interval of interest and baseline, and ΔE^* is the color difference.[15] L^*, a^*, b^*, and ΔE^* are dimensionless.

All specimens were stored in a plastic recipient, without covering, on a workbench in a laboratory that was not temperature controlled for a period of 60 days, receiving artificial light, but without direct natural light. These conditions simulated those in the prostheses during their clinical use by patients, in other words, in contact with the environment.

The specimens were disinfected daily with neutral pH soap and water (control group) or with Efferdent, three times a week. The specimens disinfected with effervescing solution were immersed for 15 minutes in a container with water into which was dropped one tablet of Efferdent. Then the specimens were removed and washed in running water. The control group specimens were submitted to disinfection with water and neutral soap scrubbing for 30 seconds with a soft bristle brush (Oral-B, Belmont, CA) and, afterwards, washed in running water.

After the disinfection periods and 60-day storage time, a new reading was accomplished, as described previously.

After obtaining the results, a variance test (ANOVA) was applied, followed by Tukey test with 1% reliability.

Results

Table 1 demonstrates the average values derived for Silastic 732 RTV and for Silastic MDX 4-4210. Statistical differences between mean color values were observed. Disinfection with Efferdent did not statistically influence the mean color values.

Table 1 General comparison of ΔE mean values and standard deviation between the silicones disinfected with Efferdent and neutral soap

	MDX	Silastic	Statistical difference
Silicones	2.24 ± 2.079	1.38 ± 0.327	Significant
Neutral Soap	3.188 ± 1.053	1.945 ± 0.330	Significant
Efferdent	1.29 ± 0.562	0.817 ± 0.349	Not Significant

Tukey test with 1% reliability.

Discussion

Many authors, including Lemon et al[4] and Ishigami et al[16] affirm that one of the factors contributing to the constant remanufacture of facial prostheses is color instability, provoked by the effects of UV rays, deposition of microscopic residues in the porosities of the material's surface, and by the use of disinfecting agents. Polyzois[17] affirmed that the exposure of facial silicone to the environment for 1 year resulted in visually detectable color changes.

Table 1 shows that MDX is more unstable, probably presenting a greater roughness, and accumulates more environmental debris (dust, smoke) and is more unstable due to its continuous polymerization. We believe that the small, but continuous release of sub-products during the continuous polymerization of silicones causes not only dimensional alteration of the silicone (shrinkage), but also alterations in its chromatic pattern. Table 1 shows that for both silicones submitted to disinfection with Efferdent, the values of ΔE were lower than the values of the groups disinfected with water and neutral soap, probably due the removal of pigments that accumulate on the specimens' surface during the storage period, increasing the final pigmentation of the material. Alkaline peroxides, such as Efferdent and Polident, are by far the most commonly used commercial denture cleansing products. These products work through an oxygen-liberating mechanism that purportedly loosens debris and removes light stain. These agents have a pleasant odor and show few reported harmful effects on the metal components of partial dentures;[18] however, a study by Langwell[19] employing a spectrophotometer concluded that commercial oxygen-based prosthesis cleansers, while removing small stains also cause the bleaching of the prostheses.

The chemical prosthesis cleansing agents depend on their mode of action, and their main constituents can be classified as: hypochlorites, peroxides, neutral peroxides with enzymes, enzymes, acids, and disinfectants;[20] however, there are reports that, depending on the composition, these cleansing chemical agents can cause deleterious effects on the resilient relining materials, causing damage to the material's physical properties, such as an increase in absorption and solubility.[21] As such, the choice of a chemical agent for prosthesis cleansing should be based not only on its antimicrobial properties, but also its compatibility, in order to preserve as much as possible the physical properties of the surface of materials.[22]

Conclusion

The factors of storage time and disinfection with Efferdent statistically influenced color stability; disinfection acts as a bleaching agent in silicone materials.

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