Effect of Extraoral Aging Conditions on Color Stability of Maxillofacial Silicone Elastomer

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Abstract

Purpose: Maxillofacial prostheses require enhancement or replacement due to deterioration in their color during service. The purpose of this study was to investigate color stability of pigmented and nonpigmented maxillofacial silicone elastomer exposed to different human and environmental aging conditions.

Material and Methods: One hundred and twelve disk-shaped silicone (TechSil S25, Technovent, Leeds, UK) specimens were prepared and equally divided into pigmented (using intrinsic rose-pink skin shade, P409, Principality Medical, Newport, UK) and nonpigmented categories of seven groups (n = 16; 8 pigmented and 8 nonpigmented): dark storage (control) (group 1), sebum solution storage (group 2), acidic perspiration storage (group 3), light aging (group 4), natural outdoor weathering (group 5), silicone-cleaning solution (group 6), and mixed conditioning of sebum storage and light aging (group 7). Conditioning periods (groups) were 6 months (groups 1, 2, 3, 5), 360 hours (groups 4, 7), and 30 hours (group 6). Color change (ΔE) was measured at the start and end of conditioning. In addition, for groups 1, 2, and 4, ΔE was measured at fixed intervals of 30 days, 15 days, and 30 hours, respectively. Data were analyzed with one-way analysis of variance (ANOVA), Dunnett's-T3 post hoc, and independent *t*-tests ($p < 0.05$). Linear regression was implemented to investigate ΔE with time for groups 1, 2, and 4.

Results: Six of the seven treatment conditions induced perceivable color change ($\Delta E > 3$). Within the nonpigmented category, specimens stored in the dark for 6 months (group 1) exhibited high ΔE (6.17), which was greater ($p < 0.05$) than that produced by silicone-cleaning solution for 30 hours (group 6) ($\Delta E = 2.08$). Within the pigmented category, light aging (group 4), outdoor (group 5), and mixed (group 7) conditionings induced greatest color changes ($\Delta E = 8.26, 8.30, 9.89$, respectively) ($p < 0.05$); however, there was a strong positive linear function of log-time after dark storage (group 1) and light aging (group 4).

Conclusions: There is inherent color instability of nonpigmented silicone elastomer, which adds to the overall color change of silicone prostheses. Storing silicone elastomer in simulated sebum under light aging induced the greatest color changes. Overall, the color stability of TechSil S25 maxillofacial heat-temperature-vulcanizing (HTV) silicone elastomer was unacceptable ($\Delta E > 3.0$, range from 3.48 to 9.89 for pigmented and 3.89 to 10.78 for nonpigmented) when subjected to six of the seven extraoral aging conditionings used in this study. Inherent color instability of nonpigmented facial silicone elastomers primarily contributes to the color degradation of extraoral facial prostheses. Sebaceous skin secretions along with daylight radiation cause the greatest perceivable color change to the silicone and pigment used in this study.

Extraoral maxillofacial prostheses are feasible treatment options for patients with surgically nonrestorable facial deformities.[1,2] It is vital that such facial prostheses are not instantly (abnormally) recognized by casual observers as replacements. Realistic pigmentation of external facial prostheses is an essential feature for patient satisfaction and acceptability.[3]

Several pigment types and opacifiers are available to camouflage prostheses with shades of tissues surrounding the defect site being restored. Moreover, different preblended

combinations of pigments and opacifiers are claimed to produce color-stable prostheses.[4-8] Preblended pigments are intended to provide initial base colors to assist the technician in creating specific patient/subject color matches. Examples of preblended pigments include P409, which is a preblended dispersion of pigments in silicone fluid, giving a natural-looking skin tone, predominantly based on Northern European and Caucasian skin types (ranging from P401 to P420) (Manufacturer instructions, Principality Medical, Newport, UK).

Maxillofacial silicone elastomers are continually developed. TechSil S25 is an addition heat-temperature-vulcanizing (HTV) vinyl blocked ($^{-}CH{=}CH_2$) poly dimethylsiloxane that undergoes crosslinking with the aid of a hydride functional siloxane copolymer, in the presence of a platinum catalyst. HTV silicones have the advantages of excellent thermal stability and physical properties, along with color stability, in comparison to room-temperature-vulcanizing (RTV) silicones.[3]

A recent study showed that TechSil S25 had a more favorable combination of high-tensile strength and elongation at break, comparable tear strength, and hardness within the favorable range in comparison to Cosmesil M511 (standard) and Cosmesil Z004 (Principality Medical);[9] however, despite the advances in silicone elastomers and pigments, with time, maxillofacial silicone prostheses discolor and deteriorate in physical and mechanical properties. The color deterioration of prostheses is a result of factors including natural climatic conditions, human body secretions, and prosthesis maintenance routines. In addition, the inherent color instability of silicone elastomers in their nonpigmented state adds to the overall color instability and discoloration of prostheses.[8] Degrading factors that affect maxillofacial silicone prostheses during function include natural outdoor environmental conditions of humidity, air pollutants, sun radiation, rain, and wind;[10-14] however, such factors are artificially simulated by accelerated rates of daylight, moisture, and air.[4,15-17]

Because finished facial prostheses may absorb perspiration and sebum from the underlying living human skin, sebaceous oil secretions and skin perspirations (i.e., acidic, alkaline) have been ISO prepared[18] and used in conditioning silicone specimens to identify their effect on silicone prostheses color and properties.[3,19,20] In addition, microwave disinfection and chemical cleaning solutions have been investigated.[6,21] Also, the effect of adhesives and cosmetics have been identified. The presence of ultraviolet (UV) light irradiation enhanced crosslinking,[14] along with accelerated interaction of fatty acids with silicone, breaks down the chain bonds and decomposes the elastomer. Also, air pollutants have been shown to affect silicone color.[19]

Whereas studies agree that variable degrees of perceivable color changes in silicone prosthesis esthetics are caused by weathering or aging, direct comparisons between the studies to identify the most degrading factor(s) were not possible. The studies vary in elastomers tested, pigments used, experimental protocols used, aging conditions, and testing methods. Furthermore, the studies investigated the effect of one,[4,5,8,13] two,[16] or three aging factors.[12,17] They indicated color change of either pigmented[12,16,17] or nonpigmented silicone specimens;[10] however, some studies investigated discoloration of nonpigmented silicone elastomer in comparison to its pigmented state.[6,8,13]

The studies distinguish between perceptible color changes and acceptable color changes. Most studies indicate perceptible color change as one[5,12,16,22] or two units.[7,15,20] Furthermore, the thresholds for perceptible and acceptable color difference of fair-skin-colored silicone specimens were reported to be 0.8 and 1.8, respectively;[23] however, a recent study indicated that CIELAB perceptibility and acceptability thresholds for light-skin-colored maxillofacial silicone specimens are 1.1 and 3.0, respectively.[24] The disagreement between both studies in the acceptability thresholds is likely due to differences in pigments and silicones used; however, for this study, color changes smaller than three units were considered visually perceptible and clinically acceptable.

The literature lacks studies comparing the effects of natural weathering and simulated aging factors on silicone elastomers in both their pigmented and nonpigmented states. This study introduced a new mixed aging mode of storing specimens in simulated sebum under continuous artificial daylight exposure. The aim of this study was to investigate color stability of pigmented and nonpigmented TechSil S25 maxillofacial silicone elastomer exposed to seven human and environmental aging conditions. The null hypothesis stated that color stability of the silicone elastomer (whether pigmented or nonpigmented) is not affected by extraoral aging factors.

Materials and methods

One hundred and twelve disk-shaped specimens were prepared (8-mm diameter, 3-mm thick) using TechSil S25 maxillofacial silicone elastomer (Technovent, Leeds, UK) and were heat cured in stone molds in a dry heat oven at 100°C for 2 hours. Half the specimens were colored using a preblended intrinsic rose-pink skin shade (P409, Principality Medical). Five drops (0.05 g) for each 10 g silicone mix were added.[25] The specimens were randomly allocated into seven groups of conditioning modes. Each group had pigmented ($n = 8$) and nonpigmented ($n = 8$) specimens. These treatment groups and conditioning periods are summarized in Table 1.

Dark storage specimens were suspended with stainless steel ligature wires in a sealed glass container and stored in the dark at room temperature (23 ± 2°C) and 50 ± 5% relative

Table 1 Study groups

Group* (n = 16)	Exposure mode	Exposure duration
1	Dry storage in the dark	6 months
2	Sebum solution	6 months
3	Acidic perspiration	6 months
4	Accelerated daylight aging	360 hours
5	Outdoor weathering	6 months
6	Antimicrobial silicone-cleaning solution	30 hours
7	Mixed aging of sebum storage under accelerated daylight	360 hours

*Each group had 16 specimens divided equally into pigmented and nonpigmented specimens.

humidity for 6 months. Sebum storage specimens were stored in simulated sebum for 6 months. The sebum was prepared by dissolving 10% palmitic acid with 2% Glyceryl Tripalmitate into 88% Linoleic acid (all w/w).[19,20] The sebum was freshly reprepared after the first 3 months.

Acidic storage specimens were stored in simulated acidic perspiration for 6 months. The solution contained the following (per liter of distilled water): 0.5 g L-histidine monohydrochloride monohydrate, 5 g sodium chloride, and 2.2 g sodium dihydrogen orthophosphate dehydrate. The solution was prepared according to International Organization for Standardization specification, ISO 105-E04:96.[18] The perspiration was freshly reprepared after the first 3 months.

Light exposure specimens were aged in an aging machine (Suntest Chamber CPS, Heraeus Instruments, Hanau, Germany) using filtered Xenon light of 150 klx and 475 W/m^2 irradiance. A complete weathering cycle lasted for 120 minutes, including 18 minutes of wet weathering by controlled flow of distilled water (29 ± 2°C), followed by 102 minutes of dry weathering (36 ± 2°C). The relative humidity inside the aging chamber was approximately 70%, and air pressure was 700 to 1060 hPa. The Xenon light was applied for the duration of aging (360 hours).

Natural weathering specimens were suspended from wooden racks using stainless steel ligature wire, and the assembly was placed on the roof of Manchester Dental School for 6 months (July 2008 to December 2008). At the end of the treatment period, the specimens were removed, cleaned for 15 minutes in distilled water in an ultrasonic cleaner (Transonic T310, Camlab limited, Cambridge, UK), incubated for 24 hours at 37 ± 1°C, and then tested. Average monthly outdoor weathering conditions are presented in Table 2. Specimens were stored in commercially available, antimicrobial silicone-cleaning solution (B-200-12, Daro Inc., Lakeside, AZ) for 30 hours.

Mixed conditioning specimens were stored in simulated sebum solution in the aging chamber of the aging machine and exposed to accelerated artificial daylight for 360 hours. The aging machine (Heraeus Suntest Chamber CPS) used filtered Xenon light of 150 klx and 475 W/m^2 irradiance.

The conditioning periods were selected to simulate silicone prosthesis in service for 12 to 18 months. Each day, patients wear their prosthesis for 8 to 12 hours, during which it is expected to be exposed to at least 1 hour of daylight, normal environmental conditions, and continuous sebum and perspiration while the prosthesis is on the defect site. In addition, before sleeping, patients spend an average of 5 minutes cleaning their prostheses. Therefore, 1 month of service equals 30 hours of daylight aging, 10 to 15 days of storage in sebum or acidic solutions, and 150 minutes of storage in cleaning solution.

The most common method to describe color is the CIE (Commission Internationale d'Eclairage) $L^* a^* b^*$ system. It describes the three color coordinates (color values) x, y, and z in three new reference values of L, a, and b, aiding in numerically classifying color differences.[5,22,26] The color measurements were performed with a colorimeter (Minolta Chroma Meter CR-221, Osaka, Japan) according to the CIELAB coordinates with a D65 standard light source. The L^* parameter corresponds to the degree of lightness and darkness (100 ideal white, 0 ideal black), and a^* and b^* coordinates correspond to red or green chroma ($+a^*$ = red, $-a^*$ = green) and yellow or blue chroma ($+b^*$ = yellow, $-b^*$ = blue), respectively. The colorimeter has a 3-mm diameter measuring area and uses a 45° illumination angle and 0° viewing angle. It was calibrated with a standard white plate, which also served as a background when color was measured. Prior to color measurements, specimens were cut-marked, and placed into a Teflon locating disk (external $\Phi = 26$ mm, internal $\Phi = 8$ mm, thickness = 3 mm) to ensure readings were made at the same location on each specimen before and after treatments. Color measurements were recorded at baseline and at the end of conditioning periods for all groups. In addition, color measurements were recorded every month for group 1, every 15 days for group 2, and every 30 hours for group 4. The color change (ΔE) was calculated using the following equation:

$$\Delta E = ([\Delta L^*]^2 + [\Delta a^*]^2 + [\Delta b^*]^2)^{1/2}$$

where ΔL^*, Δa^*, and Δb^* are the differences in the respective values before and after aging. Specimens were gently cleaned, rinsed in water, and ultrasonically cleaned for 5 minutes (Transonic T310, Camlab Ltd.) before each color measurement.

One-way ANOVA (release 16, SPSS, Chicago, IL) was applied to test significant differences between the seven treatment conditions ($p < 0.05$) for each pigmented and nonpigmented specimen. Since ANOVA assumes equal variances across the specimens, all data were subjected to Levene's test of homogeneity of variance ($\alpha = 0.05$), following the assumption of equal variances. Accordingly, the equal variance assumption was rejected ($p < 0.05$), and Dunnett's T3 multiple comparison

Table 2 Monthly average radiation and climate data during outdoor weathering

Date	Temperature °C (F)			Wind speed (knots)	Rainfall (mm)	Global radiation (kj/m^2)	Sunshine (hour)
	Min	Max	Mean				
July 2008	12.3 (54.14)	20.0 (68.0)	16.2 (61.2)	7.9	3.5	16,397.5	4.7
August 2008	12.7 (54.9)	19.4 (66.9)	16.1 (61.0)	7.7	2.9	11,873.8	2.6
September 20008	9.2 (48.6)	17.0 (62.6)	13.1 (55.6)	5.8	3.1	9421.4	3.4
October 2008	5.8 (42.4)	12.8 (55.0)	9.3 (48.7)	8.5	4.6	5947.7	3.0
November 2008	4.0 (39.2)	9.0 (48.2)	6.6 (43.9)	7.7	1.8	2605.4	1.8
December 2008	−0.9 (30.4)	6.1 (43.0)	2.6 (36.7)	6.2	2.5	2161.9	2.2

Data source: Met office. Woodford location, Greater Manchester, England.

test was used to compare the groups. Within each conditioning method, a *t*-test for independent data (release 16, SPSS) was performed to investigate the effect of pigments on color change ($p < 0.05$).

Results

Mean values and standard deviations for ΔE, ΔL*, Δa*, and Δb* of both pigmented and nonpigmented specimens are presented in Table 3 and Figures 1 and 2. Figure 3 shows the correlation between ΔE and log-time for both pigmented and nonpigmented specimens for dark storage, sebum solution, and artificial daylight conditions. ΔE was found to be a positive linear function of log-time for pigmented and nonpigmented specimens of the dark storage ($r = 0.942$ and 0.903, respectively) and artificial daylight ($r = 0.870$ and 0.679, respectively) conditions. Within the pigmented category, mixed aging induced the greatest color changes ($\Delta E = 9.89$) ($p < 0.05$). Within nonpigmented specimens, antimicrobial silicone-cleaning solution induced the least color changes ($\Delta E = 2.08$) ($p < 0.05$). Color change of pigmented specimens was significantly greater ($p < 0.001$) than that of nonpigmented specimens, when specimens were exposed to outdoor weathering only. All treatment conditions (except antimicrobial cleaning solution of pigmented specimens) induced visually detectable color change ($\Delta E > 3$). Changes in the color coordinates of both pigmented and nonpigmented specimens are as follows:

Value (L*)

In the L*a*b* system, the L* parameter corresponds to the degree of lightness and darkness (100 ideal white, 0 ideal black). For pigmented specimens, whereas both time passage and acidic perspiration aging caused specimens to be less bright ($p < 0.05$), specimens became brighter when exposed to accelerated light aging, outdoor weathering, and mixed aging ($p < 0.05$) (Fig 1). For nonpigmented specimens, time passage and accelerated light aging caused specimens to become less bright ($p < 0.05$) (Fig 2).

Table 3 Mean values and standard deviations of ΔE of both pigmented and nonpigmented specimens with different conditions

	ΔE	
Group	Pigmented	Nonpigmented
Dry dark storage (control)	4.72 ± 1.84^{a}	6.17 ± 1.65^{a}
Sebum solution	3.48 ± 1.13	5.66 ± 3.07
Acidic perspiration	6.26 ± 2.82	4.51 ± 2.08
Artificial daylight aging	8.26 ± 0.95^{b}	7.87 ± 5.16
Outdoor weathering	¥ 8.30 ± 1.23^{b}	¥ 3.89 ± 2.52
Antimicrobial cleaning solution	1.92 ± 1.82	2.08 ± 1.25^{b}
Mixed aging	9.89 ± 1.24^{b}	10.78 ± 4.32

ΔE > 3 was considered as visually perceivable and clinically unacceptable.
Different superscript letters in the same column indicate the only significant differences presented in ΔE ($p < 0.05$) after applying one-way ANOVA and Dunnett's T3 multiple comparison tests.
Symbol (¥) in the same row indicates significant differences ($p < 0.05$) after applying independent *t*-test.

Red/green chroma (a*)

In the L*a*b* system, a positive a* value indicates red chroma, whereas a higher positive a* indicates a more intense red chroma, and lower positive indicates less intense red chroma. A negative a* indicates a green chroma, whereas a higher absolute value of a negative a* (a more negative number) indicates a more intense green chroma. For pigmented specimens, whereas both aging conditions (time passage and sebum storage) caused specimens to be less red ($p < 0.05$); specimens became greener when exposed to accelerated light aging, outdoor weathering, and mixed aging ($p < 0.05$) (Fig 1). For nonpigmented specimens, only outdoor weathering caused specimens to become a significantly more intense green ($p < 0.05$) (Fig 2).

Yellow/blue chroma (b*)

In the L*a*b* system, a positive b* indicates a yellow chroma, whereas a higher positive b* indicates a more intense yellow chroma. A negative b* indicates a blue chroma, whereas a higher absolute value of a negative b* (a more negative number) indicates a more intense blue chroma. For pigmented specimens, all aging conditionings caused specimens to be less yellow ($p < 0.05$) (Fig 1). For nonpigmented specimens, whereas specimens became less yellow when stored in dark (time passage) and exposed to accelerated light aging; specimens became more intense in yellow when aged in sebum solution ($p < 0.05$) (Fig 2).

Discussion

Material discoloration is an indication of the material's adverse reaction to the surrounding environment. Solar radiation, moisture, temperature, airborne pollutants, and routine cleaning induce color changes within maxillofacial silicone prostheses.[13] Factors affecting long-term color stability of a maxillofacial silicone elastomer were evaluated in the present study. All specimens, whether pigmented or nonpigmented, underwent different amounts of color changes regardless of conditioning treatment. Accordingly, the null hypothesis was rejected. This is in accordance with other studies.[4,15-17]

Within pigmented specimens, light aging, outdoor, and mixed conditionings induced the greatest ($p < 0.05$) color change ($\Delta E = 8.26$, 8.30, 9.89, respectively). The presence of UV light irradiation (whether accelerated or normal) may have enhanced crosslinking,[14] along with accelerated interaction of fatty acids with silicone, breaking down the chain bonds and decomposing the elastomer.[20] Also, air pollutants affect the color of specimens.[19]

The premixed intrinsic skin shade pigment used has a predominantly greater portion of red pigments. The great color change presented is mainly due to the loss of red pigment by the irradiated lighting, as yellow and burnt sienna pigments are reported to be color stable in comparison to red pigments over different exposures;[6,7] however, variations in the degree of color degradation are related to silicone elastomer used, pigment types, concentration of opacifiers, and aging type.[4-6]

Within the nonpigmented category, specimens stored in a sealed dark chamber away from any activation exhibited high color change ($\Delta E = 6.17$), which was greater than ΔE

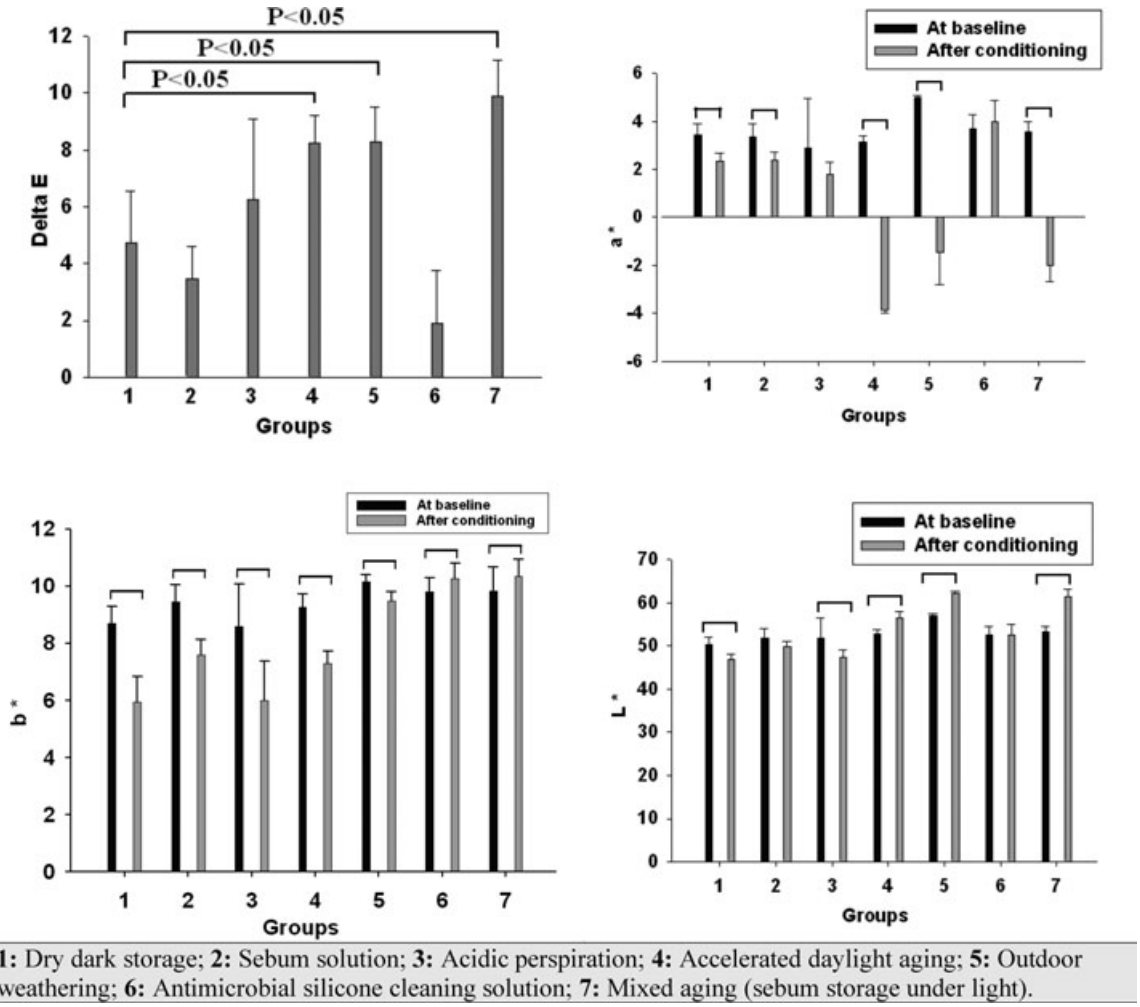

Figure 1 Changes in color (ΔE) and respective coordinates (a*, b*, L*) of pigmented silicone specimens after different types of conditions. Horizontal lines above bars represent significant differences between paired groups ($p < 0.05$). 1: Dry dark storage; 2: Sebum solution; 3: Acidic perspiration; 4: Accelerated daylight aging; 5: Outdoor weathering; 6: Antimicrobial silicone-cleaning solution; 7: Mixed aging (sebum storage under light).

exhibited by silicone-cleaning solution ($\Delta E = 2.08$) ($p < 0.05$). There was a significant positive correlation of color change (deterioration) over time for both pigmented and nonpigmented specimens stored in the dark (Fig 3).

As there was no sort of activation excerted on these specimens (i.e., light, chemical, or mechanical), continual chemical polymerization of the silicone is the main factor. It is likely that the continuous release of subproducts during the continuous polymerization of silicones causes not only dimensional alteration of the silicone (shrinkage), but also alterations in its chromatic pattern; however, the presence of aging/activation (whether chemical or mechanical) probably removes pigments that accumulate on the specimens' surface during the storage period, increasing the final pigmentation of the silicone elastomer.[21]

It is always advisable for patients to use mild detergent in cleaning their prostheses.[21] On the other hand, nonpigmented specimens placed in the dark exhibited greater color changes than equivalent pigmented specimens. Pigments may exert a stabilizing effect on the elastomers' color;[8] however, the silicone specimens were processed in stone molds, and silicones are not completely polymerized in stone molds.[27,28]

On the other hand, pigmented specimens exposed to natural weathering exhibited greater color changes ($p < 0.05$) when compared to the equivalent nonpigmented specimens. This might be caused by the environmental factors of temperature, light, moisture, and air pollutants presented in the atmosphere surrounding the specimens.

Progressive tracking of color changes of silicone prostheses over time is useful to investigate the color stability of silicone elastomer during service. Different studies reported color changes at different intervals, making direct comparison impossible.[10,12,13,20] The color of specimens stored in the dark, sebum solution, and under artificial daylight aging was recorded at fixed intervals corresponding to a simulated clinical service

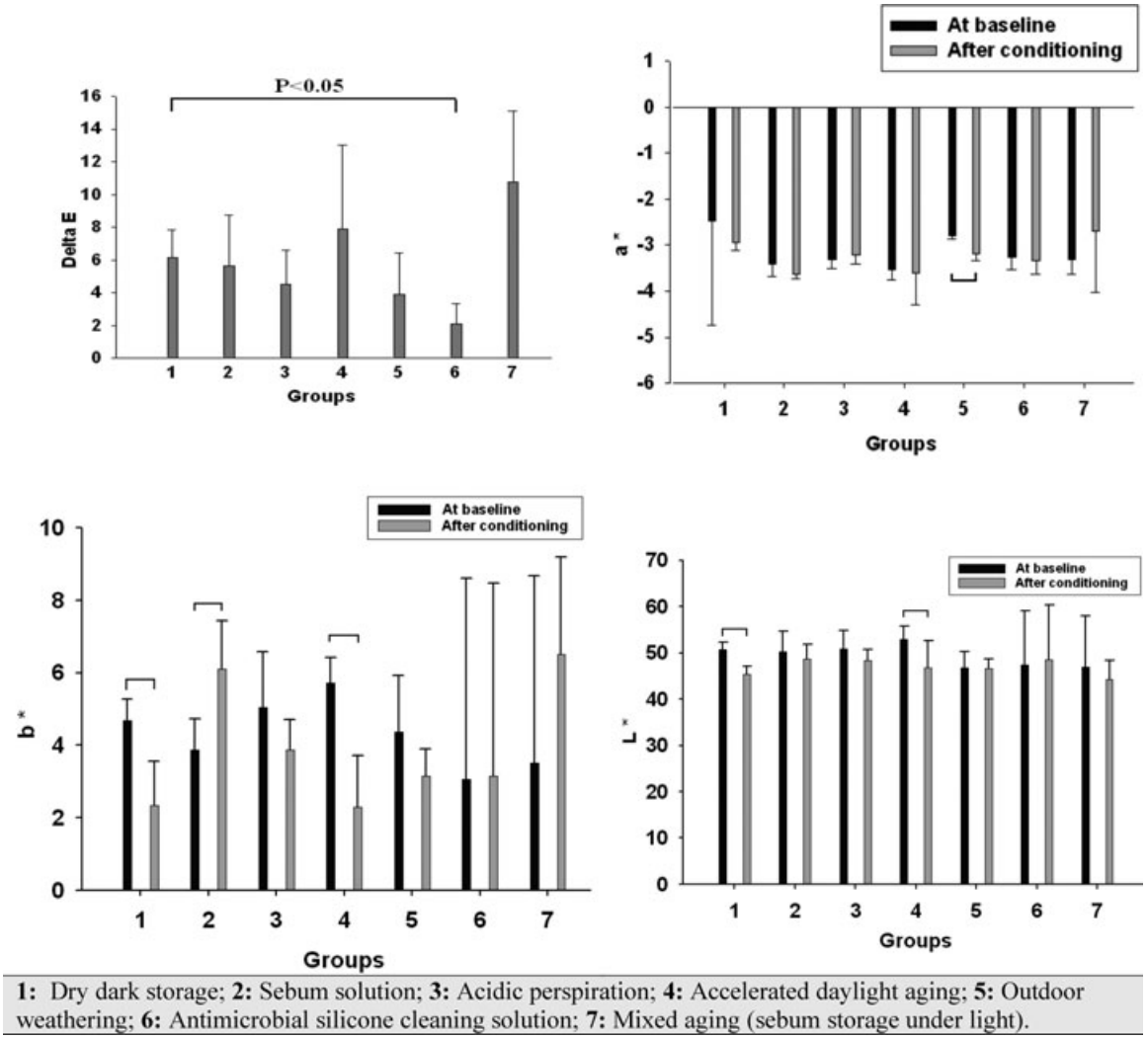

Figure 2 Changes in color (ΔE) and respective coordinates (a*, b*, L*) of nonpigmented silicone specimens after different types of conditions. Horizontal lines above bars represent significant differences between paired groups ($p < 0.05$). 1: Dry dark storage; 2: Sebum solution; 3: Acidic perspiration; 4: Accelerated daylight aging; 5: Outdoor weathering; 6: Antimicrobial silicone-cleaning solution; 7: Mixed aging (sebum storage under light).

of 30 days. For pigmented specimens, there was a trend toward an increase of ΔE with increasing log-time for the dark storage and light-aged specimens. Furthermore, both treatments presented a strong liner correlation between ΔE and log-time as confirmed by high r values. For the dark storage specimens, r was 0.942 and p was 0.005, while for the light-aged specimens r was 0.87 and p was 0.001.

On the other hand, for nonpigmented specimens, there was a trend toward an increase of ΔE with increasing log-time for the dark storage and light-aged specimens. Furthermore, the dark storage specimens presented a strong liner correlation between ΔE and log-time as confirmed by high r (0.903) ($p = 0.014$), while for light-aged specimens r was 0.679 and p was 0.015.

For maxillofacial silicone prostheses, perceptible color changes have been reported differently as one[5,12,16,22] and two units.[7,15,20] Furthermore, the thresholds for perceptible and acceptable color difference of fair-skin-colored silicone specimens were reported to be 0.8 and 1.8, respectively.[23] A recent study indicated that CIELAB perceptibility and acceptability thresholds for light-skin-colored maxillofacial silicone specimens are 1.1 and 3.0, respectively.[24] The disagreement between the acceptability thresholds in both studies is likely due to differences in pigments and silicones used; however, for this study, color changes smaller than three units were considered visually perceptible but clinically acceptable. Accordingly, specimens (whether pigmented or not) treated with antimicrobial silicone-cleaning solution induced clinically acceptable color changes.

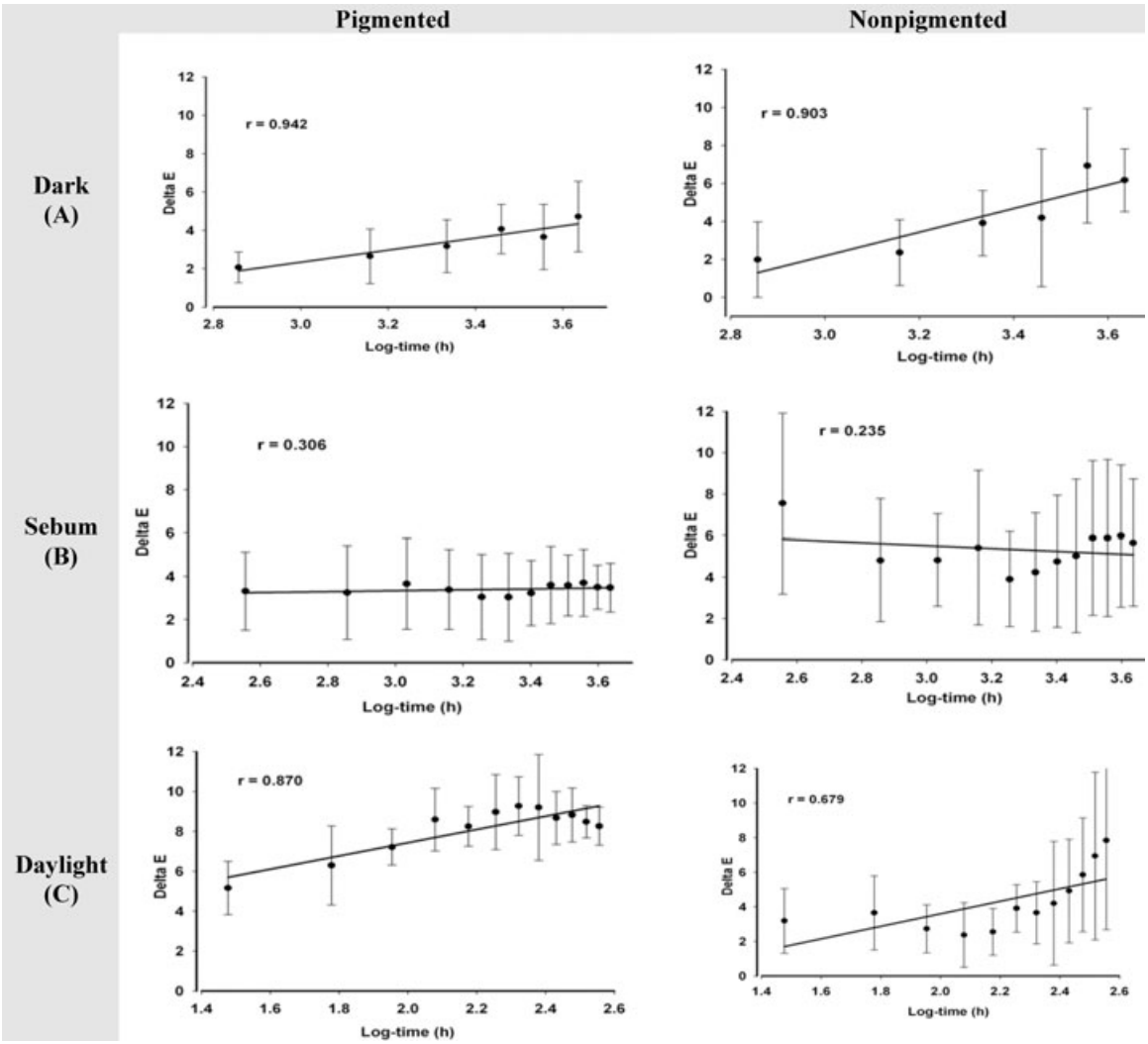

Figure 3 Mean values of color change (ΔE) as a function of log-time for pigmented and nonpigmented silicone specimens after dry dark storage (A), sebum solution (B), and artificial daylight (C) conditions.

The TechSil S25 silicone elastomer used in this study, despite its reported comparable mechanical properties to commonly used silicone elastomer,[9] suffers color instability. Inherent color instability of nonpigmented TechSil S25 silicone elastomer primarily contributes to the color degradation of facial prostheses. Sebaceous skin secretions, along with daylight radiation, caused the greatest perceivable color change.

Maxillofacial silicone prostheses, in normal functioning, are exposed to different levels of all conditioning elements presented in this study, rather than intensive sole aging of solar radiation, concentrated chemicals, or wet environments; however this study does give data on accelerated color changes of new maxillofacial silicone elastomer (TechSil S25), whether pigmented or nonpigmented. It also introduces a novel conditioning procedure of storing silicone specimens in sebum solution under accelerated exposure to artificial daylight.

Conclusions

Within the limitations of this in vitro study, it can be concluded that for maxillofacial silicone elastomer TechSil S25:

(1) There is strong inherent color instability of nonpigmented silicone elastomer, which adds to the overall color change of the silicone prosthesis over time.
(2) Storing the silicone elastomer in simulated sebum solution under continuous exposure to artificial daylight aging induced the greatest color changes in pigmented specimens.
(3) Silicone-cleaning solution on its own did not induce perceivable color changes in specimens. Overall, the color stability of TechSil S25 maxillofacial HTV silicone elastomer was unacceptable (ΔE greater than 3.0, range from 3.48 to 9.89 for pigmented and 3.89 to 10.78 for nonpigmented) when subjected to six of the seven extraoral aging conditionings used in this study.

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