A Spectrophotometric Evaluation Of Effects Of Disinfection And Aging Conditions On The Color Stability Of Maxillofacial Silicones Material

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Abstract: *Background:* The replacement of intricate facial structures requires the use of man-made external prosthesis despite improvements in re-constructive and plastic surgery. Special effects artists began their career in prosthetics and makeup artists create their own prosthetics. Also considering the psychosocial pressures for facially disfigured patients, there is an increasing need to improve the prosthetic materials that are in use and to synthesize new elastomers, specially for use of a facial prosthetic material. *Materials:* Maxillofacial Silicone material (M511 and Z004) *Methods:* A total of 40 samples were made from Skin colored Maxillofacial silicone materials of light and dark specimens and divided into two main group: Group A and Group B (20each).The main groups were then subdivided into five subgroups (A1B1, A2B2, A3B3, A4B4, A5B5,)(Outdoor weathering, acidic perspiration, sebum, neutral soap and disinfectant). Subjects were subjected to extraoral aging conditions and analysed. *Equipments:* Spectrophotometer *Results:* There was no statistical significance between the two materials when subjected to extraoral aging conditions. *Conclusion:* The purpose of this poster is to focus on artificial intelligence regarding prosthetic materials used in the construction of extra oral Maxillofacial prosthesis that used to restore missing or defective ear, nose or eye.

Introduction: 'You can dress up in the most extravagant costume, and paint the most intense makeup over your entire body, but nothing screams different louder than physically altering your bodily structure. You're not a beast until you have an extended forehead. You're not a demon until you have horns. You're not a mutant unless you have those little spikey things in a pattern down your back. In the entertainment industry, these are accomplished with what is known as special effects prosthetics'.[4] Such radical changes should not be taken lightly. A good actor and director know how to make a successful monster without altering appearance. Rather, prosthetics are best used for impact or to represent deviation from the normal or a change that has taken place. Like any other prop, they should accentuate the character and help explain its personality, not stand in for it.[4]

Maxillofacial prosthetic treatment allows many patients with orofacial defects to return to an active role in public. The results of prosthetic treatment are influenced by the nature of the defect, the skill of the prosthodontist, and the properties of the materials used. The most critical properties are esthetics, durability, and accuracy of processing. Patients are concerned with the durability and esthetics of the prosthesis. A prosthesis must be durable, esthetic, and color stable[1] James Lemon et al studied color stability of facial prosthesis and concluded that changes occurred in the color of the samples, with artificial aging causing a greater change than outdoor aging[1]. Muhanad M. Hatamleh, et al[2] suggested that Accelerated aging of silicone specimens in simulated sebum under artificial daylight for 12 months of simulated clinical service greatly affected functional properties of silicone elastomer; however, in real practice, the effect is modest, since sebum concentration is lower, and daylight

is less concentrated. Marcelo Coelho Goiato, et al concluded that the factors of storage time and disinfection statistically influenced color stability; disinfection acts as a bleaching agent in silicone materials[3]. Tania sethi et al suggested that Silicone elastomers are materials that have properties suitable for making prostheses for replacing lost bodily organs. Their biocompatibility, flexibility, ability to be colored artistically render them ideal materials for this purpose. Some of their inherent drawbacks such as their hardening and loss of colour are topics of exciting current cutting edge research in this field[5] Aldie´ ris Alves Pesqueira et al concluded that the ceramic pigment presented greater color stability regardless of disinfection and period. On the other hand, the makeup pigment exhibited the highest values of chromatic alteration[6] Various material used for Maxillofacial prosthesis are Heat-vulcanized silicones, Maxillo-facial materials, Room temperature vulcanized Silicones, etc[7]

Silicones have many desirable properties including biocompatibility, ease of manipulation, low viscosity, and patient accommodation properties (i.e. nontoxic, easily cleansable, lightweight, compatible with adhesives). Moreover, they have high tensile strength, high elongation, and sufficient bonding to underlying substrates. But silicone based.

Maxillofacial prostheses require replacement every 6 to 18 months, as they suffer deterioration in physical and mechanical properties and discoloration upon service[2]. Thus, this in vitro study evaluated and compared the color stability of two commercially available Maxillofacial silicone elastomers after subjecting them to extraoral aging conditions like; outdoor weathering, skin secretions, and disinfectant solutions.

Subjects and method: M511 Maxillofacial rubber (Part A: Part B = 10:1) (Technovent series material, Principality Medical Ltd., South Wales, UK) and Z004 Platinum silicone rubber (Part A: Part B = 1:1) (Technovent Ltd., Newport, UK) were used for the study. Both the silicones are room temperature vulcanizing silicones. A precise stainless steel mold with a depression measuring 30 mm in diameter and 3 mm in thickness was customized.

M511 Maxillofacial rubber Fig.1

Z004 Platinum silicone rubber Fig .2

Customized stainless steel mold Fig 3

Ten Polyvinyl siloxane putty impressions were obtained using the mold and were invested in large Maxillofacial flask. After the stone was set, the VPS putty samples were peeled off the mold leaving behind accurate depressions measuring 30 mm in diameter and 3 mm in thickness [Figure 3].

A standardized procedure was followed for the staining procedure for the specimens. Intrinsic stains were extensively used to mimic the average Indian medium skin tone.[8] The Maxillofacial silicone was mixed and cured according to the manufacturer's instructions. Taking into consideration, the experimental errors that would occur during the study, the sample size was taken to be as 4 per

group. A total of 40 specimens were selected and divided into Group A (Technovent 10:1) and Group B (Technovent 1:1).

Further, each group was divided into five subgroups depending on the extraoral aging conditions, they were subjected to as follows: A1B1 (outdoor weathering), A2B2 (acidic perspiration), A3B3 (simulated sebum solution), A4B4 (neutral soap solution), and A5B5 (disinfection solution).

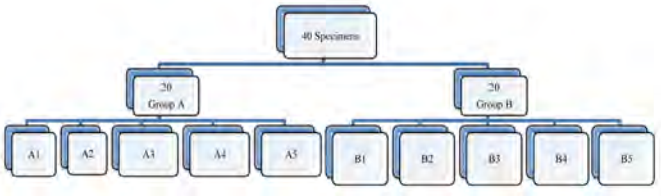


Fig .4

Abbreviations:

A1B1 : Outdoor weathering

A2B2 : Acidic perspiration

A3B3 : Simulated sebum Solution

A4B4 : Neutral soap solution

A5B5 : Disinfectant solution

For the subgroup A1B1, the specimens were subjected to maximize the amount of sunlight on the specimens.[9] The whole assembly was placed on the roof for 3 months.

For the subgroup A2B2, the specimens were immersed in simulated acidic perspiration for 3 months, which was prepared by adding L-Histidine monohydrochloride monohydrate-0.5 g, sodium chloride-5 g , and sodium dihydrogen orthophosphate dehydrate-2.2 g per liter of distilled water.[9]

For the subgroup A3B3, simulated sebum solution was by mixing palmitic acid-10%, glycerine tripalmitate-2% and linoleic acid-88% (all w/w)and the specimens were stored in it for 3 months.[2]

The specimens of subgroup A4B4 and A5B5 were immersed in neutral soap solution (Johnson and Johnson soap solution) and disinfectant solution (Clinsodent Effervescent denture cleansing tablets) respectively, for 30 h[9]

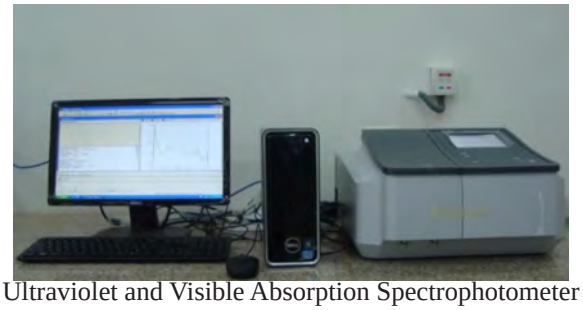
Color differences of each specimen were measured using Ultraviolet and Visible Absorption Spectrophotometer (UV-VIS) [Model no. UV -1800,Company name Shimadzu, Japan] using the system to measure the color alteration.

L*, a*, and b* values of each specimen after immersion at each specified time interval (T0, T30 h, and T3 m) was measured and the mean was calculated. Color difference ΔE was calculated from the mean ΔL*, Δa*, and Δb* values for each specimen with the formula.[9]

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

Where ΔL*, Δa*, and Δb* are the differences in L*, a*, and b* values before (T0) and after immersion at each time interval (T30 h and T3 m).

Ultraviolet and Visible Absorption Spectrophotometer (UV-VIS) Fig.5



Ultraviolet and Visible Absorption Spectrophotometer (UV-VIS) Fig.5

Results: Values of ΔE* ≤3 were considered clinically acceptable. Values more than 3 reflected unacceptable color change clinically as suggested by Fontes et al.[10] The values obtained did not follow a normal curve/Gaussian curve, and hence nonparametric tests were employed. The intergroup comparison was done by Kruskal–Wallis test, whereas the intragroup comparison was done by Mann– Whitney test Values of ΔE* ≤3 were considered clinically acceptable. Values more than 3 reflected unacceptable color change clinically as suggested by Fontes et al. Any ΔE value more than 3 was considered to be a visually perceptible color change from the baseline reading.[9]

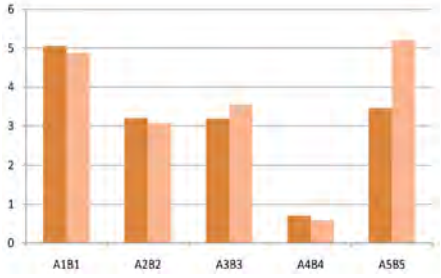
The results showing the mean difference of mean ΔE*, SD, and P value of Group A and B are presented in Table 1

Table 1: Mean difference of ΔE and Standard deviation of Group A and Group B at different time intervals (intergroup comparison using Kruskal-Wallis test)

Subgroups	Mean	Standard deviation
A1	5.05	1.39
A2	3.20	2.89
A3	3.19	1.65
A4	0.70	0.28
A5	3.45	1.74
B1	4.88	1.81
B2	3.07	0.92
B3	3.54	2.08
B4	0.58	0.30
B5	5.21	2.46

Table 2 : Comparison of mean ΔE values of Group A and Group B specimens at different time intervals

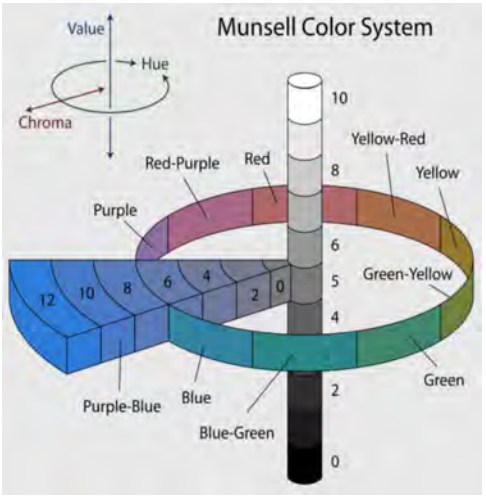
A1B1	A2B2	A3B3	A4B4	A5B5
5.05	3.20	3.19	0.70	3.45
4.88	3.07	3.54	0.58	5.21



Graph 1

Group A versus Group B mean difference
0.17
0.13
-0.35
0.12
-1.76

Discussion: Color stability is the property a material has, of retaining color for a period of time in a certain environment. Two of the color systems used to assess the chromatic differences are the Munsell color system and the CIE L*a*b* color system. Cantor et al.[11] reported methods for evaluating prosthetic facial materials. The authors investigated the esthetics of the materials and color matching of skin and facial materials using reflectance spectrophotometry. Since then, reflectance spectrophotometry and color and optical density have been used to evaluate the color stability.



Munsell color system Fig. 6

The deterioration of the color of the Maxillofacial silicone prosthesis is not by virtue of a single factor or aging condition. Infact, it is due to the combined effect of various factors such as environmental exposure, humidity, UV radiation, air pollutants, exposure to facial secretions, and the method of disinfection. Apart from these external factors, certain internal factors such as the composition of the silicone, degree of cross-linking, mode of curing, extrinsic and intrinsic stains used; all play an important role in maintaining or degrading the color of the silicone prosthesis.[9]

The ADA recommends the use of CIE L*a*b* system, which quantifies the color alterations using a mathematical equation expressed by ΔE* and obtained with the variation of three coefficients (L*a* and b*) where,

L* = Color luminosity (ranging from 0-black to 100-white)

a* = Ranges from 90 to 70 and represent the greenness on the positive axis and redness on the negative axis

b* = Rang es from 80 to 100 and represents yellowness (positive b*) and blueness (negative b*).

ΔE = (*ΔL+2 + *Δa+2 + *Δb+2)1/2

There was a highly statistically significant color change that was noted in the specimens before and after outdoor weathering irrespective of the material being used similar to the studies conducted by Lemon et al[1] This significant color change can be attributed to the presence of UV light irradiation present in the solar radiation which may have enhanced cross-linking, along with accelerated interaction of the fatty acids with silicone, breaking down the chain bonds, and decomposing the elastomer as suggested by Hatamleh et al.[2]

Within the limitations of this in vitro study and from the results obtained, the following can be inferred.

- All the specimens produced a statistically significant color change when subjected to extraoral aging conditions
- Immersion in neutral soap solution does not produce a statistically significant color change irrespective of the material used.
- There was no statistically significant difference in the color stability of M511 Maxillofacial Rubber (Part A: Part B = 10:1), Technovent series material and Z004 Platinum Silicone Rubber (Part A: Part B = 1:1), Technovent Ltd that were compared in the study.

The limitations of this study include:

- Evaluation of the color stability of the materials was done based on intrinsic staining only.
- The effect of outdoor weathering on color stability is limited to the areas with tropical climatic conditions.
- Manipulation of the Maxillofacial silicone elastomer was done by mechanical hand mixing.

Conclusion: Immersion of the specimens in neutral soap solution produced the least color change irrespective of the material used.The results of this study can give an insight into how different Maxillofacial silicone elastomers may behave when exposed to different extraoral aging conditions, thus affecting the clinician's choice of material and the patient's concern toward the prosthesis

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