When you think of the people you love, what do you picture? Most likely, you see their faces. Our faces, more than any other part of the body, are symbolic of our identities and serve immeasurable social, psychological, emotional, and communicative purposes. So when someone is born with or acquires a facial deformity that requires prosthetic restoration, the prosthesis must be not only comfortable and functional, but aesthetically faithful to real human tissue to preserve or create a person's unique visual character. Of particular concern is ensuring perfect color matching to create a harmonious and authentic appearance.

While color matching is an important part of many prosthetic apparatuses, never is it more significant than in the production of maxillofacial elastomers. Due to the highly visible nature of maxillofacial materials and the tremendous impact their appearance can have on a patient's self-esteem and overall quality of life, realistic coloration is essential. As such, the base shade and subsequent pigmentation of the silicone elastomer via intrinsic or extrinsic coloring agents are chosen with the patient's specific skin color in mind to produce a seamless match. Given the critical nature of these devices, subjective visual chromatic assessment is not enough and clinicians are increasingly turning to spectrophotometers to ensure color harmony. As researchers from the Ohio State University College of Dentistry note, "Compared with a chairside visual trial-and-error method and facial skin shade guides, instrumental colorimetric or photometric techniques … provide more consistent, reliable, and quantitative assessment of an object's color under controlled conditions."[1] Non-contact spectrophotometric analysis offers the highest level of chromatic precision to recreate skin tones and is considered the gold standard in maxillofacial elastomer color measurement.

Towards Improved Pigmentation

Unfortunately, even an ideal initial color match is short-lived. Each maxillofacial prosthetic currently has an average lifespan of only 6-18 months, primarily due to color changes over time that render them aesthetically insufficient. These changes are caused by environmental factors such as sunlight, heat, and body oils, as well as the disinfection procedures these prosthetics are subjected to daily to maintain safety. Not only can this rapid replacement rate be time-consuming and frustrating for patients, it can also be extraordinarily expensive and a patient's inability to keep up with the intense replacement schedule can lead to very real emotional distress.

In order to improve color durability, researchers are experimenting with incorporating opacifiers and UV absorbers in silicone elastomers. By combining spectrophotometric instrumentation with artificial aging procedures, researchers are able to accurately capture the effect of various stabilizing additives over time. One study, published in the Journal of Dentistry, found that pigments "mixed with 10% and 15% Artskin white and titanium white dry pigment opacifiers protected silicone…from color degradation over time."[2] UV mineral-based light protecting agents have also been shown to keep silicone elastomer pigmentation within the range of clinical acceptability and offer greater color stability protection than other popular opacifiers.[3] As research continues, more stable pigmentation formulations may significantly increase the longevity of maxillofacial prosthetics and increase patient satisfaction.

Spectrophotometric Evaluation of Disinfection Methods

Spectrophotometers are not only being used in the development of new silicone pigmentation processes, but in the evaluation of disinfection methods to prolong the lifespan of prosthetics. A group of Greek and American researchers studied the effects of microwave exposure, hypochlorite solution, neutral soap, and a commercial disinfecting solution on medical grade polydimethylsiloxane (PDMS) and chlorinated polyethylene (CPE) samples to simulate ordinary, daily use over the period of one year.[4] Using a HunterLab MiniScan XE spectrophotometer (now the MiniScan EZ 4500L), the color of the samples was measured prior to disinfection to establish a baseline and measured again after disinfectant exposure. The precision of spectrophotometric analysis allowed the researchers to observe even slight color variations. When the results were in, all of the disinfecting methods produced an eye detectable color shift, but PDMS disinfected via microwave exposure

and CPE disinfected via hypochlorite solution fell within the range of clinical acceptability. All other material and disinfectant combinations were considered clinically unacceptable. As a result, the researchers were able to make meaningful and objective recommendations to help patients prolong the lifespans of their prosthetic devices and guard against premature color change.

Full article with photos available here:

https://www.hunterlab.com/blog/color-plastics/how-spectrophotometers-are-increasing-color-harmony-and-stability-in-maxillofacial-prosthetics/