Importance of skin color in therapeutic and diagnostic applications

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INTRODUCTION

Human skin color tones fall within a small gamut of the complete spectrum of color. It is difficult to describe skin tones in verbal expression. However, now with the help of a conceptual entity — color space — color can be expressed in numerical figures. These values are useful in comparing tones for medical research, industrial cosmetic use, and the like. Many color space variations — Commission Internationale de l’éclairage L*a*b* (CIE L*a*b*), sRGB (Standard Red Green Blue), Adobe RGB (Adobe Red Green Blue), HSV (Hue Saturation Value), and CMYK (Cyan Magenta Yellow Black), have been described and preferred according to the need [Table 1]. CIE L*a*b* space is a device-independent color space that consists of three axes L*, a*, and b*. All colors can be accommodated within the coordinate values in L*, a*, and b* color space. Difference in color values can be expressed in terms of CIE delta E*ab. When the delta E*ab values are more than 2.5, it produces a significant color difference noticeable to the naked human eye.

COLOR SPACES

There are variations of skin color within the sun-exposed and sun-covered parts of our body. Even among twins there are color differences. Skin color of the gluteal region represents constitutive color, whereas, the color of the cheek represents a facultative color. Epidermal melanin and melanosome size influences the L* (lightness) values. Constitutional dark skin has a lower L* value.[1] Erythema and tanning can be measured objectively using colorimetry. The a* values indicate erythema, while the b*(yellow-blue) values indicate tanning, and the transition from erythema to tanning can be measured objectively.[2] Exposed areas like the cheek have increased a* values, which indicate a red-green axis because of increased vascularization.[3] The b* value also increases in direct proportion with the carotenoid level of the skin.[4] There is an 8.2% increase in skin reflectance values for every ten degrees of increase in latitude in the Northern hemisphere, in males. Only a 3.3% increase has been noted for the latitudes in the Southern hemisphere, indicating that the skin color is darker in the Southern hemisphere for the corresponding latitude.[5]

The color of newborns can provide information about their health status. Similarly the color space values of the skin of aged persons can provide information about their health, nutritional status, and the like. The color of ulcers varies over a period of time indicating the healing process. There was a 5 nmol/L increase in 25 hydroxy vitamin D3 levels for every 10 degrees of lower colorimetric skin values in the forearm (exposed skin), indicating that the forearm color can be a reliable indicator for the vitamin D3 status.[6]

IN SKIN DISEASES

A minimal erythema dose (MED) was defined as an increase in the a* value by 2.5 units. A significant risk for melanoma was found with increasing a* values in patients.[7] An objective assessment of erythema in psoriasis was useful in the determination of the Psoriasis Area and Severity Index (PASI) scores.[8] There was a significant relationship between the L* values and MED values of the skin, but this was not significant for the a* and b* values.

The MED value for Narrowband Ultraviolet B (NBUVB) radiation has become a basic criterion for the phototherapy protocol. Hence, the skin type and L*
value are useful for predicting the response to NBUVB therapy. The L* value can replace MED estimation for starting Narrowband UV therapy. The starting doses based on L* values are given — 300 mJ/cm² when the L* value is more than 66, 400 mJ/cm² when the L* value is between 62 and 66, and 500 mJ/cm² when the L* value is less than 62. The L*a*b* values can be used to measure the difference in pigmentation in vitiligo. In patients with Acanthosis nigricans, the L* values are found to correlate with hyperpigmentation.

COSMETOLOGY

The color of scars can be evaluated with the help of L*a*b* coordinates and can be reliable for assessing the color contrast with normal skin. In grafting, L* and a* values of skin grafts can be compared with the adjacent recipient skin, which will be useful in the final cosmetic outcome. Similar matching can be done between the skin flap of the donor and recipient sites. The skin of the upper extremities and the trapezius flaps of Caucasians, South Asians, and Southeast Asians match closely for grafts required in the cheek and other facial regions. Color data obtained from a spectrophotometer is used for color mixing and preparation of a facial prosthesis. The L*a*b* values are used to compare the silica prosthesis with the original color of the subject. The highest correlation is found in the b* values for a prosthesis with a thickness of 1-4 mm. Good correlation was found with the L* values when the thickness was 6-10 mm. The whitening effect on the skin color (Lightness Value) of the pigmented lesions can be compared after the use of intense pulsed light (IPL), in patients using this technique.

DERMATOPHARMACOLOGY

Digital analysis of photographs was found to be useful to assess the prick test reaction to histamine and dermaphagoides antigens, and tests were done at 0-, 3-, 5-, 10-, 15-, and 29-minute intervals. The efficacy of drugs in controlling the flare reaction of histamines was assessed in a study and color space values were found to be useful. Difference in the skin color a* values were assessed for postural changes in the limbs, during a vasoconstrictor assay using topical corticosteroids.

EFFECT OF TOXINS

The skin color of End Stage Renal Disease (ESRD) Taiwanese patients on dialysis were compared with the controls, on the sun-exposed and sun-covered regions of the body. It was observed that the L* values were lower in the sun-covered areas in both hemodialysis and peritoneal dialysis patients. In another study on the maintenance of hemodialysis patients, the skin was found to have significant hyperpigmentation when compared with the matched controls. Patients who stopped smoking were assessed for their skin color changes. Lightness of skin improved and the redness decreased 12 weeks after cessation of smoking. The Melanin Index and Erythema Index reduced significantly after four weeks of smoking cessation.

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