Scar Treatment Variations by Skin Type

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KEYWORDS

• Scar • Skin color • Melanin • Pigmentation • Hypertrophic • Keloid • Laser • Ethnicity

KEY POINTS

- Patients and clinicians use skin color attributes such as color uniformity, color distribution, and texture to infer physiologic health status.
- Normalization of skin color, surface texture, and height are important treatment goals.
- Skin color, structure, function response to trauma, and scar formation vary with ethnicity.
- The incidence of hypertrophic and keloid scar formation is influenced by these inherent variations.
- Skin type influences the response to various modalities including laser therapy and surgical intervention, and skin differences must be considered in treatment planning to achieve optimal results.

INTRODUCTION

Deep tissue wounds, burns, and surgical incisions can result in the formation of scars, that is, erythematous, firm, pruritic, raised fibrous masses that remain within the boundaries of the original wound, and may regress over time.[1] Scars frequently have significant morbidity and psychological, cosmetic, and functional outcomes as well as overall quality of life.[2] Patients seek treatment to improve the color, texture, surface roughness, pliability, range of motion functionality, and pain.

This paper discusses the impact of skin color and ethnicity on the physiologic characteristics of scars and on the evaluation of treatment efficacy. The implications of ethnic diversity in the selection of treatment strategies are examined.

SKIN COLOR

Clinical judgments of scar progression and treatment effectiveness depend on perception of the skin surface.[3] Humans use skin color attributes such as color uniformity, color distribution, and texture to infer physiologic health status.[4–8] In one study, subjects were asked to adjust the red color of high-resolution facial images to achieve a "healthy appearance". All of them increased the red color, regardless of the inherent pigmentation, but dark skin subjects increased the red color of dark skin photos more than lighter skin photos.[4] Visual responses to facial images standardized for shape and surface features were measured. Images with more uniform skin coloration were perceived to be younger than those with greater

Funding Sources: None.
Conflict of Interest: None.

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Facial Plast Surg Clin N Am 22 (2014) 453–462
http://dx.doi.org/10.1016/j.fsc.2014.04.010
1064-7406/14/$ – see front matter

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color variability.[9] These factors can reduce the perceived age by as many as 20 years.[10,11] The perception of age may vary however depending on the viewer's ethnicity. High-resolution images of facial skin (cheek region) of Japanese women aged 13 to 80 years were perceived to be older by Japanese observers if the skin was darker (L value) and more yellow (b*).[12]

Perceived skin color occurs when visible light interacts with skin components such as constitutive pigments melanin (yellow to brown), oxygenated hemoglobin (red), deoxyhemoglobin (blue-purple), bilirubin (yellow), and carotene (yellow).[13] Observed color arises from the interplay of light with components of the stratum corneum (SC), epidermis, and dermis and by diffuse reflection, scattering, and absorption of light inside the skin.[13,14] About 5% of incident light is reflected back to the eye, whereas the remainder is absorbed, scattered, or transmitted within the SC, epidermis, dermis, and subcutaneous tissue.[6] The SC transmits light, the epidermis and dermis absorb some light due to melanin and hemoglobin, and the subcutaneous fat scatters light.[15] The Vancouver Scar Scale (VSS), commonly used to evaluate scars, infers vascularity from color descriptors, pigmentation from color due to melanin, height relative to the surrounding tissue, and pliability by palpation.[16]

SKIN STRUCTURE, FUNCTION, COLOR, AND ETHNIC DIVERSITY

Skin color is commonly described by 2 systems:

1. Fitzpatrick skin type
2. Von Luschan skin coloration

The Fitzpatrick skin type system has 6 classifications based on inherent color and the response to ultraviolet radiation.[17] An anthropologist, Fredrick Von Luschan, described skin coloration in the late 1900s.[18] **Fig. 1**, and **Table 1** compare these systems in relation to skin color.

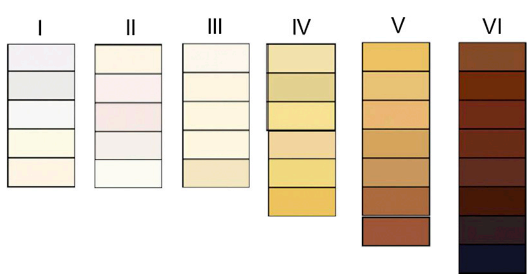

Fig. 1. The skin colors described by Von Luschan are shown in relationship to the Fitzpatrick skin types I to VI.

Melanin, water, hemoglobin, and other chromophores absorb the incident light to varying extents, depending on the wavelength. Melanin synthesis occurs in the basal layer of the epidermis and is transferred to the keratinocytes throughout the epidermis.[19] Melanin levels are higher in dark versus light skin and the latter has greater amounts of light melanin including pheomelanin and dihydroxyindole-2-carboxylic acid–enriched eumelanin.[20] Additionally, African skin is characterized by significantly larger melanosomes than Indian, Mexican, Chinese, and European skin and size is greater in Indian than in European skin.[20,21] Oxygenated blood in the dermal capillaries and vascular plexus and deoxygenated blood (blue-purple) in the dermal venules contribute to skin color.[22] Bilirubin (yellow) in the epidermis results from precipitation in phospholipid membranes and leakage as a complex with albumin into extravascular regions.[23] Skin coloration for a given individual varies with season due to differences in the amount of light exposure.[24]

Melanin (M) content can be approximated from measurements of red reflectance using the equation $M = \log_{10}$ (1/% red reflectance), and erythema (E) can be determined from the equation $E = \log_{10}$ (1/% green reflectance) $-$ $\log_{10}$ (1/% red reflectance).[25,26] Narrow band reflectance spectroscopy and CIE L*a*b* tristimulus color have been used to measure erythema, melanin, L*, and a* in various ethnic skin types (**Fig. 2**).[25] For subjects with lesser pigmentation, E and M are relatively independent and can be used to estimate erythema and melanin content. However, because E and M are correlated, they cannot be used to assess redness or melanin content for dark-skinned subjects.

Most of the published reports on ethnic skin comparisons have focused on the SC and epidermis rather than on exploring dermal and subcutaneous features.[27] The vascular response to a topical corticosteroid (clobetasol) using laser Doppler technique was decreased in African Americans versus Caucasians and paralleled the reduction in erythema in earlier studies by the same investigators.[28] The mechanism responsible for this effect was not discussed. Evaluations of three-dimensional reconstructed dermal equivalents and human tissue samples found the dermal-epidermal junction from African skin to have more epidermal projections, greater convolution, and to be more uniform than in Caucasian skin.[27] African tissues had lower amounts of laminin 5, nidogen proteins, type IV collagen, and type VII collagen than Caucasians. The syntheses of keratinocyte growth factor and monocyte chemotactic protein-I were higher in African papillary fibroblasts.