Comparison of Skin Color Measurements between Digital Imaging and Colorimeter
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Background and Objective: Skin color status has a major impact on dermatology and cosmetics. It’s essential to develop a kind of more objective measurement method of skin color.

Materials and Methods: The paper compares the difference between digital imaging by re-Beau instrument (JMEC, Tokyo) and colorimeter by CR-13 instrument (Konica Minolta, Tokyo) through testing 91 volunteers aged between 18 to 60 years old with three sites including forehead left cheek and jaw. Since CIE-L’$a$’b’$b$ is widely used for evaluating skin color, the RGB values of the captured face image are converted to tristimulus value XYZ and then L’$a$’b’$b$’ is calculated. In CR-13’s instrument, L’a’b’$b$’ values are displayed directly. Erythema is evaluated using the a’ parameter. Pigmentation is evaluated by the values of L’, b’ or combinations of them. Calculated parameter based on the L’a’b’$b$’ system is the individual typology angle (ITA) and hue angle (h$_{ab}$). There are defined as the vector direction in the L’-b’ or a’-b’ plane: ITA=$\{\tan^{-1}(L’-50)/b’\} \times 180/\pi$, h$_{ab}$=$\tan^{-1}(b’/a’)$. According to ITA values, skin color can be classified into the following categories: Very light(I)>55°, Light(II) 55°~41°, Intermediate(III) 41°~28°, Tan(IV) 28°~10°, Brown(V) 10°~30°, Dark(VI) <30°.

Results: The results are expressed in Fig.1. There are significant differences in different instruments. The ITA data is more dispersed in re-Beau instrument compared to CR-13 instrument, while hue angle data of CR-13 is higher than re-Beau. According to re-Beau data, there’s significant difference in cheek of people before 30 years old and after 30 years old. ITA grade of cheek focus on III/IV/V in people aged over 30 years old. However it focuses on II/III/IV in people aged before 30 years old. This parameter has been validated as an expression of skin pigmentation by analysis of measurements.

![Fig.1 Distribution of skin color](image)

Conclusion: We believe digital imaging data is more accurate and objective than colorimeter, because backscattered red light is more likely to escape the aperture of the colorimeter due to a greater mean distance between scattering events in colorimeter.