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Original article

Reliable facial color analysis using a digital camera and its relationship with pathological patterns: A pilot study

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Abstract

Introduction: According to East Asian medicine (EAM) theory, facial color serves as a diagnostic clue to pathological conditions. The aim of this pilot study was to examine the relationship between facial color parameters and EAM pathological patterns.
Methods: A total of 23 normal subjects participated in our study. The subjects were asked to complete Yin deficiency, Phlegm, Cold-Heat, and Food Retention Questionnaires. After taking digital photographs of the subjects' faces, L^* (luminance), a^* (red-green balance), and b^* (yellow-blue balance) values of the five facial regions (forehead, left and right cheeks, nose, and chin) were calculated. We randomly selected 10 samples and conducted intra- and inter-rater reliability tests. Finally, we examined the relationship between L^*, a^*, and b^* values and the four pattern questionnaires scores.
Results: Intra-class correlation coefficients of intra- and inter-rater reliability ranged from 0.640 to 0.994. Cold pattern scores had a positive correlation with L^* values and a negative correlation with a^* values of the left and right cheeks and nose regions ($r = 0.573$, 0.565, and 0.534), and had a negative correlation with a^* values of the forehead and nose regions ($r = -0.447$, -0.576). Heat pattern scores had a negative correlation with the left and right cheeks regions ($r = -0.466$, -0.440). Yin deficiency and Food Retention Questionnaire scores had a negative correlation with b^* values on the left cheek region ($r = -0.415$, -0.523).
Conclusions: We conclude that facial color analysis using $L^*a^*b^*$ values is reliable, and facial luminance and color are indicative of EAM pathological patterns.

Keywords: Facial inspection; $L^*a^*b^*$; Pathological pattern; East Asian medicine

Introduction

Among the diagnostic methods of East Asian medicine (EAM), inspection is a technique whereby a clinician observes the exterior of a patient's body, face, and tongue with his or her eyes, for the purpose of determining the condition of the patient's health and illnesses [1]. The face is where the 12 meridians gather (either directly or indirectly), and therefore it is considered to be a reflection of one's vitality and pathological conditions [1,2]. According to EAM theory, blue, red, yellow, white and black colors are enhanced when bodily or mental pathological conditions are present. For example, blueness on the skin or face is indicative of blood stasis or Cold pattern, whereas paleness on the skin or face represents blood deficiency, also Cold pattern [1]. The relationship of enhanced colors with pathological conditions is known as the 'five colors as a clue to pathological conditions' [1].

Facial inspection parameters consist of facial colors and gloss. Determination of facial color by vision is subjective, and therefore some color parameters including RGB (R: red, G: green, B: blue) and $L^*a^*b^*$ (L^*: luminance, a^*: red (+)/green

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(−) balance, b^*: yellow (+)/blue (-) balance) have been proposed not only to objectively estimate facial colors, but also to address the clinical utility of the color parameters. The $L^*a^*b^*$ system is one of the standard color models used to describe all visible colors and contains information on luminance [3]. Stephen et al. reported that facial redness enhanced perceived aggression, dominance, and attractiveness in men's faces [4]. Wu et al. compared L^*, a^*, and b^* values from a health group and sub-health group measured using a spectral photometric color measuring instrument, and found that L^* values of the sub-health subjects were higher than those of the health subjects and a^* and b^* values of the sub-health subjects were lower than those of the health subjects [5]. However, a limitation of these studies is that spectrophotometers are too expensive to be widely applied to clinical cases. Recently, digital cameras have become popular in many medical fields, including ophthalmology, dermatology, and dentistry, because of their easy-to-use interfaces and cost-effectiveness [6–8]. When quantifying facial inspection information using a digital camera, the intra- and inter-rater reliabilities must be guaranteed. Therefore, the first purpose of our study was to calculate facial L^*, a^*, and b^* parameters using a simple and cost-effective digital camera and digital imaging software, and then to examine whether this color analysis method has satisfactory intra- and inter-rater reliabilities.

The second purpose of our study was to examine whether facial color parameters had significant relationships with EAM pathological patterns. As one's face reflects pathological conditions, it is plausible that calculated color parameters would be related to pathological pattern measures. To objectively estimate pathological patterns, we used self-rating questionnaires for Yin deficiency, Phlegm, Cold-Heat, and Food retention patterns that have been previously developed and validated [9–12].

In summary, in this study we calculated L^*, a^*, and b^* parameters of facial regions using a digital camera and digital imaging software and examined whether this color analysis method had acceptable intra- and inter-rater reliabilities. We also examined whether facial color parameters were indicative of pathological patterns as estimated by self-rating pattern questionnaires.

Methods

Subjects and data collection

Fig. 1 depicts the entire process of our study. Twenty-three young subjects participated in this study during November 2012, in Seoul, Korea. Based on self-reports and visual inspection by a Korean medical doctor who was a member of "The Society of HyungSang Medicine," with clinical experiences more than ten years for facial inspection, subjects with facial flushing, freckles, acne, and eruptions, which could affect facial color, were excluded. The subjects' ages ranged from 21 to 38 years. Among the 23 subjects, 14 were male, and 9 were female. During completion of the pattern questionnaires and photographing of the subjects' faces, room temperature was maintained at 22–23 °C to prevent each subject from flushing. Informed consent forms were obtained from all subjects.

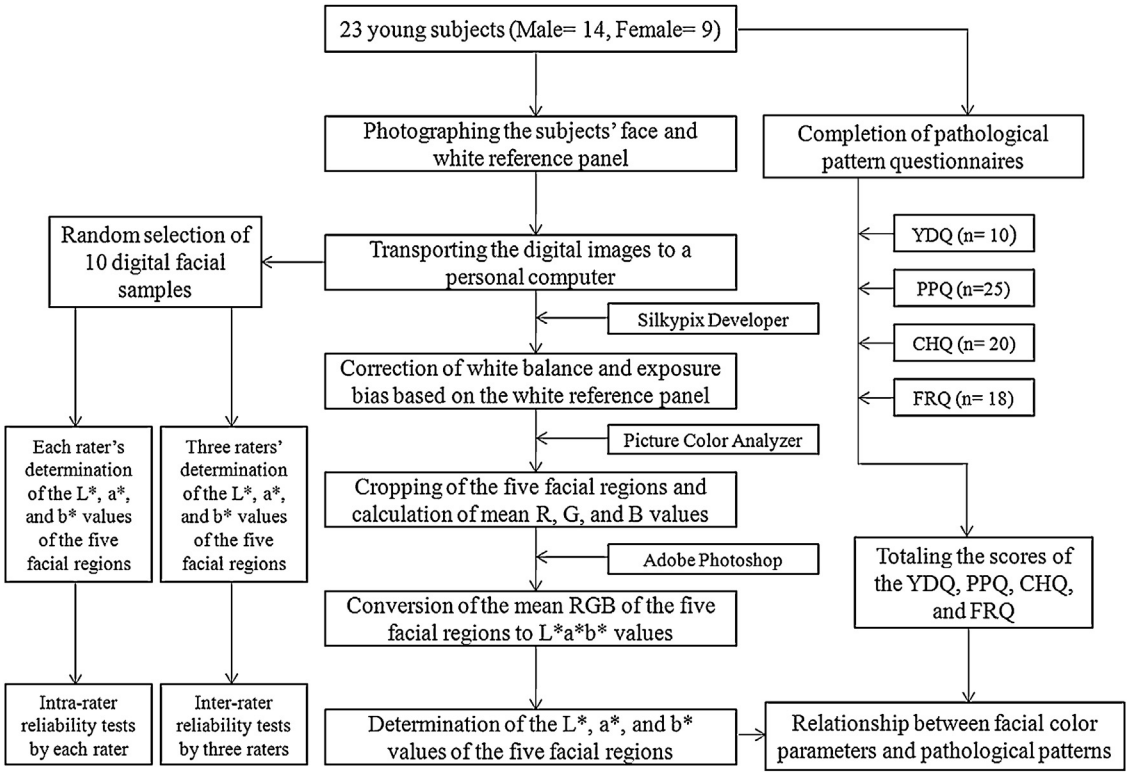

Fig. 1. Flow chart of the examination of the relationship between facial color parameters and the four pathological pattern questionnaire scores. ROIs: regions of interest, YDQ: Yin Deficiency Questionnaire, PPQ: Phlegm Pattern Questionnaire, CHQ: Cold-Heat Questionnaire, FRQ: Food Retention Questionnaire.