VALIDATION OF HAIR GREYING MEASUREMENT USING ANTERA 3D® HANDHELD CAMERA TO INVESTIGATE THE EFFECTS OF TREATMENTS FOR CANITIES

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Poster ID 552

Introduction:

The color of hair mostly relies on the presence or absence of melanins. The physical surface characteristics of hair fiber only add minor modification in the perceived color. The range of hair colors derives from the different relative proportions of eumelanins (brown/black) and pheomelanins (red/yellow). Like skin, hair is ageing and one of the most noticeable signs of this phenomenon is the loss of pigmentation or canities [1-3]. The etiology of hair greying is still unclear but grey hair is believed to occur either from insufficient melanin formation due to melanocyte degeneration or a defect in melanosomal transfer to keratinocytes. Risk factors associated with canities include some auto-immune disorders but also external causes such as oxidative stress, nutritional deficiencies to mention just a few. The roles of genes in human hair greying is still poorly understood but heredity is likely to play a role. Finally, it must be kept in mind that the visual perception of grey hair can derive from "true" grey hair but also from the admixture of darkly pigmented hair and white hair.

Because this problem equally affects both women and men and can occur relatively early in life, it constitutes an important aesthetic concern. In our laboratory, we had previously used digital photography to successfully substantiate anti-grey hair treatments by using a large photographic bench. Colorimetry is another method frequently used for in vivo measurements but it presents some limitations. Therefore the aim of this study was to investigate whether the multi-purpose handheld Antera 3D® camera (Miravex, Dublin, Ireland) could be used to more easily monitor hair pigmentation in the context of in vivo cosmetic testing.

Materials & Methods:

Assessment of hair color measurement accuracy by Spectrophotometry

Athough chromametry / spectrophotometry is frequently used for hair color measurement, we had some doubts about the accuracy of such an approach. Indeed one of the main problems encountered during the analysis of human hair is the difficulty to obtain a representative sampling. Hair can exhibit differences in terms of color, surface properties, along the length of the fibre from root to tip. Brushing adds another source of variation in the visual appearance of hair covering the scalp. Colorimeters and spectrophotometers measure color in a highly localized manner due to the small diameter of the probe aperture. However it is common to define one region of interest to perform the measurement, and to use a repositioning system to ensure that measurements are always made on the same site during studies with two or more different timepoints. Because of the intrinsic variability of hair color along fibres and the impossibility to control the brushing and hair styling during a study, we assumed that another approach was necessary. Instead of trying to measure exactly the same site, we performed repeated measurements (n=15) by moving the probe over an area of approximately 3 cm². Measurements were performed with a Spectrophotometer CM700d (Konica Minolta, Japan) using L*a*b* values and the so-called Individual Typological Angle ITA°. Because it is likely that the global hair color could influence the accuracy, measurements were done on wigs in which increasing number of grey and white hair were added.

Definition of the settings for photographic acquisitions and color image analysis

Looking for an alternative to chromametry / spectrophotometry, we decided to evaluate the potentials of digital photography for hair color assessment. Photographs of the mid-scalp area of Asian subjects were acquired with either the handheld Antera 3D®. camera or with a photographic system developed by the Spincontrol company called Visio-Face®. A preliminary step consisted in defining experimental conditions allowing to accurately reposition the subjects and to control lighting and photographic conditions. First, we used a dedicated system, Visio-Face®, which allows to accurately reposition the subjects and to reproduce similar lighting and photographic conditions This system is based on a Nikkon D300 reflex digital camera equipped with a Pro micro Nikkor AF 2.8/60 mm lens (Nikon Corporation, Tokyo, Japan) associated with two flash lights Elinchrom style 600 RX flashes (Elinca SA, Renens, Switzerland). The analysis of grey hair was done on regions of interest of approximately 4 cm² through the L*a*b* colour space coordinates. These L*a*b* values were mathematically converted from the red, green and blue (RGB) values constituting the digital photographs by a piece of software developed by Spincontrol. Figure 1 present[s] setup used for the acquisition of photographs of the [Spincontrol's Visio-Face® benchmark.

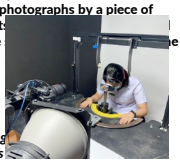


Fig. 1: View of the Viso-face benchmark and positioning Of the subjects for the acquisition of head photographs

A similar positioning of the subjects was used for the acquisition of scalp photographs with the Antera 3D® handheld camera. For color measurement, L*a*b* values were directly given by the Antera 3D® software.

Repeatability, reproducibility and linearity

Repeatability and reproducibility of digital photography and Antera 3D®. were determined from triplicate measurements made on 5 subjects presenting different level of grey hair intensity (Fig. 2). One pure white hair wig was also used to test the most extreme possible situation.

Fig. 2:

Additionally, experiments were carried out by mixing increasing numbers (200, 400, 600, 800 and 1000) of white human virgin hair taken from hair tresses with natural black hair of subjects *in vivo* in order to test the linearity of the two methods over a large range of grey hair conditions.

Results & Discussion:

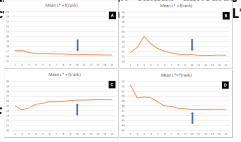
Hair color measurement accuracy by Spectrophotometry

For the assessment of a darkening effect, the lighter the hair, the higher are the L* and ITA° values. Among the variables investigated (L*a*b* and the Individual Typology Angle ITA°), the Luminance L* was found to be the most sensitive parameter for the quantification of grey hair severity. Therefore all the results reported in this paper concern L* only.

L*a*b* and ITA° were measured 15 consecutive times on wigs containing increasing number of grey and white hair by Spectrophotometry. Results are presented in Fig. 3.

When we consider the curves presented in Figures 4A to 4D, where the average Luminance L* values are plotted as a function of the measurement ranks, we noticed that, in all cases, i.e. whatever the grey hair coverage, plateau are reached around the 10th measure and the mean values converge to a stable value, increasing the accurac[y] L* of the hair of the subjects.

Fig. 3:



Settings for photographic acquisitions

Repeatability of L* values determined with the Antera 3D® software in subjects exhibiting varying degrees of canities ranged between 0.8% and 6.2%, depending on hair greying severity (coefficients of variation). Reproducibility of L* values determination ranged between 1.3% and 8.7%. Repeatability of L* values determined from digital photographs were found to be in the range 0.7%-10.9% and reproducibility between 0.4% and 12.5% depending on canities severity.

Linear relationships between the Luminance L* and the number of white hair were found for both the Antera 3D® camera and the Spincontrol's Visio-Face® benchmark (Fig. 4, left and right respectively). However the two extreme colors (pure black and pure white) cannot be accurately measured. This is not a critical issue s[ince] hair or totally nts for canitie[s]

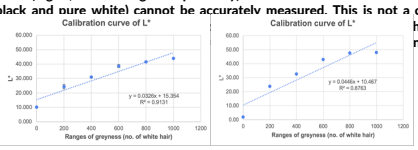


Fig. 4:

Conclusions:

Publications about substantiation of cosmetic and pharmacologic interventions for canities are very scarce [5-8]. Often the methods used for evaluation and/or quantification of grey hair relies on clinical grading, either performed *in situ* or on photographs, sometimes it is done through counting grey/white hair on photographs. In this work, we have shown that Antera 3D® represents a reliable tool for the quantitative measurement of the hair greying phenomenon. Reproducibility, repeatability and sensitivity were found to be very satisfactory and results correlated well with Luminance L* determination obtained by image analysis of photographs acquired with a more sophisticated benchmark. Therefore Antera 3D® is a reliable, cost- and time-effective method to measure differences in hair grey intensity before and after cosmetic interventions. In addition to the monitoring of the reversibility of hypopigmentation of hair, the Antera 3D® handheld camera could also be used to assess the effectiveness of camouflage techniques such as hair dying. One limitation from this work comes from the fact that all experiments were performed with Asian subjects. Nevertheless it is most likely that grey hair quantitative assessment with the Antera 3D® system will also be possible in Caucasian subjects with light or dark brown hair. However it remains to be demonstrated whether this technique could be used in subjects with blond or red hair, where pheomelanin is the major pigment.

References:

1. O'Sullivan JDB, Nicu C, Picard M, et al (2021) The biology of human hair greying. Biol Rev 96: 1075–1091.
2. Triwongwaranat D, Thuangtong R, Arunkajohnsak S (2019) A review of the etiologies, clinical characteristics, and treatment of canities. Int J Dermatol 58: 659-666.
3. Tobin DJ, Paus R (2001) Graying: gerontobiology of the hair follicle pigmentary unit. Exp Gerontol 36: 29-54.
4. Vaughn MR, van Oorschot RAH, Baindur-Hudson S (2009) A comparison of hair colour measurement by digital image analysis with reflective spectrophotometry. Forensic Sci Int 183: 97-101.
5. Singal A, Daulatabad D, Grover C (2016) Graying severity score: a useful tool for evaluation of premature canities. Indian Dermatol Online J 7: 164-167.
6. Trüeb RM (2006) Pharmacologic interventions in aging hair. Clin Interv Aging 1: 121-129.
7. De Tollenaere M, Chapuis E, Auriol P, et al (2021) Global repigmentation strategy of grey hair follicles by targeting oxidative stress and stem cells protection. Appl Sci 11: 1533.
8. Jo SJ, Shin H, Paik SH, et al (2013) Efficacy and safety of *Pueraria lobata* extract in gray hair prevention: a randomized, double-blind, placebo-controlled study. Ann Dermatol 25: 218-222.