OBTAINING NATURAL TOOTH COLOR WITH DIGITAL PHOTOGRAPHY – CLINICAL STUDY ON 30 PATIENTS

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Abstract

Objectives. *The aim of this study is to determine the correct exposure compensation, in order to obtain pictures with natural teeth color characteristics using a selected camera.*

Methods. *The maxillary arch of 30 patients was photographed using a Canon 400D digital camera with Canon 100 mm macro lenses and MR-14EX flash in standardized conditions: manual mode, f 22, 1/125 shutter speed, magnification ratio 1:2, WB – flash; using four different exposure compensation settings: 0 (A), 1/3 (B), 2/3 (C), 1 (D) for each patient. A 6 mm² area from the buccal surface of the maxillary central incisor 1.1. was measured from the photographs using the DetColorDent 1.0. software. The CIE L*, a*, b* values were obtained. A spectrophotometer, Vita Easy Shade (Vita, Germany) was used as control, measuring the same area of the selected tooth. A second set of L*, a*, b* values was obtained and the ΔE was calculated. The ΔE values < 3.4 were considered clinically acceptable. The results were statistically analyzed using the SSPS 13.0 for Windows - Mann Whitney test.*

Results. *The ΔE values obtained were situated in the interval 2.99-25.68. The highest number of ΔE values lower than 3.4 were obtained for the exposure compensation setting 'C' (56%). For this case, the mean value of ΔE_C was 5.43±2.46, CI 95% = [4.41; 6.44]. There was a significant difference between ΔE_C and ΔE_A, ΔE_B, ΔE_D ($p \leq 0.001$).*

Conclusions. *The digital images obtained by using camera Canon 400D revealed natural color mainly for the exposure compensation setting 'C'.*

Keywords: digital photography, tooth color, CIELab.

UTILIZAREA FOTOGRAFIEI DIGITALE PENTRU REDAREA CULORII NATURALE A DINȚILOR – STUDIU CLINIC PE UN LOT DE 30 DE PACIENȚI

Rezumat

Obiectiv. *Scopul studiului este de a determina care este nivelul expunerii corecte, în vederea obţinerii unor imagini care să redea culoarea naturală a dinţilor fotografiaţi, utilizând sistemul fotografic ales.*

Material şi metodă. *Arcadele dentare a 30 pacienţi au fost fotografiate, utilizând un sistem fotografic compus din: aparat foto Canon EOS 400D SLR, lentile Canon 100 mm f 2.8 USM, blitz circular Canon MR-14EX, cu următoarele setări: mod de lucru manual, f 22, 1/125, rata de mărire 1:2, WB – flash, TTL II, ISO 100, 3888x2595 pixeli. Pentru fiecare pacient s-a realizat un set de 4 fotografii, variându-se la fiecare fotografie compensarea expunerii, astfel: 0 (A), 1/3 (B), 2/3 (C), 1 (D). S-au analizat imaginile obţinute, iar unei zone circulare de 6 mm² de pe suprafaţa vestibulară a incisivului central maxilar drept, 1.1., i s-au determinat parametrii culorii utilizând software-ul DetColorDent 1.0. Valorile L*, a*, b* - sistemul CIE Lab au fost obţinute. Spectrofotometrul Vita Easy Shade (Vita, Germania) a fost utilizat ca martor, măsurându-se parametrii culorii ale aceleiaşi zone de pe incisivul central maxilar drept. Un al doilea set de valori L*, a*, b* a fost obţinut şi ΔE* a fost*

calculată. Valorile ΔE mai mici decât 3,4 au fost considerate ca acceptabile din punct de vedere clinic. Rezultatele au fost analizate statistic utilizând programul SPSS 13.0 for Windows, testul - Mann Whitney.*

Rezultate. *Valorile ΔE obţinute s-au situat în intervalul 2.99-25.68. Cel mai mare număr de valori ale ΔE mai mici decât 3.4 au fost obţinute pentru setarea blitz-ului la valoarea 'C' (56%). Pentru acest caz, media ΔE*C a fost 5.43±2.46, CI 95% = [4.41; 6.44].*

Concluzii. *Fotografiile digitale obţinute au redat culoarea naturală a dinţilor preponderent pentru setarea compensării expunerii blitz-ului la valoarea 'C' (2/3).*

Cuvinte cheie: fotografie digitală, culoarea dentară, CIELab.

Introduction

In recent years, the evolution of photographic equipment and image editing programs, led to their use of objective assessment of color in dentistry. This equipment is able to record digital images that can be viewed on a computer, stored in databases or transmitted over the Internet. Images or portions them can be analyzed using specialized imaging software. This technology is much cheaper and easy to be accessed by the dentist compared to other instrumental methods tools such as dental spectrophotometers or colorimeters.

The computerized analysis of images taken by digital technology, already a simple and available technique to any doctor and technician can provide important information that will certainly lead to achieving superior results.

Communication dental office - Dental laboratory equipment with the purpose to transmit information about future restoration appearance (shape, color, position, etc.) is often poor. Dental technician often has no contact with the patient and works only on indications that the doctor provides in the examination chart. They may be more or less complex, but often limited to basic color indicating required eg A3 color - color key Vita Classic - no other references (distribution of color, translucency and pigmentation areas additional features of shape, fireworks position, etc.). The computerized analysis of images taken by digital technology, already a simple technique and available to any doctor and technician can provide important information that will certainly lead to achieving superior results.

Choosing equipment for photography, involved in obtaining adequate images for dentistry, it is sometimes difficult and requires a good knowledge of the equipment on the market accommodates and scope of its use.

The technical parameters of digital cameras used in dentistry are well known, but some factors are still difficult to control. The correct illumination of the tooth is controlled by various factors; among these, exposure has a major influence on the final result [4,5].

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Objective

The aim of this study is to determine the correct level of exposure compensation, in order to obtain pictures with natural teeth color characteristics using a selected camera kit, in a dental practice reproducible conditions.

Methods

The maxillary arch of 30 patients were photographed using the following photographic system (Fig. 1): Canon 400D (body), with Canon 100 mm f 2.8 USM macro lenses and MR-14EX ring flash.

Fig. 1. The photographic system.

Fig. 2. Camera settings.

The images were taken under the following standardized camera settings (except the exposure compensation) for all the images (Fig. 2):

• manual mode M; aperture value: F 22; 1/125 shutter speed;

• magnification ratio 1:2 – for repeatability;
• White Balance – flash (color temperature 5500K);
• TTL II; ISO 100; Resolution 3888x2595 pixels;
• Manual focus – focus on the left maxillary canine, the camera was hand -held .

With the settings described above we take the photographs using four different exposure compensation settings of the flash (increasing each time 1/3 of a stop): **0** (A), **1/3** (B), **2/3** (C), $\mathbf{1}_{1/3}$ (D) - and we obtained a set of 4 images for each patient (Fig. 3).

The analysis of the digital images

Each image obtained was analyzed using the computer software, **DetColorDent 1.0**, developed for this study in Babes–Bolyai University. The buccal surface of tooth 1.1. was marked with a circular transparent sticker, having a circular 6 mm^2 hole, applied to all patients before the images were taken. This area was analyzed with the computer software and the L_1*, a_1*, b_1* values from the CIE Lab color space were obtained (Fig. 4).

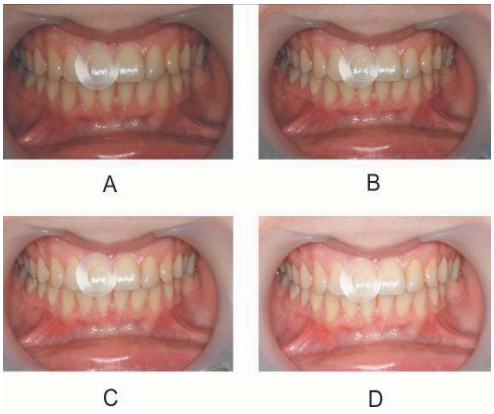

Fig. 3. Image set of 4 pictures obtained for each patient.

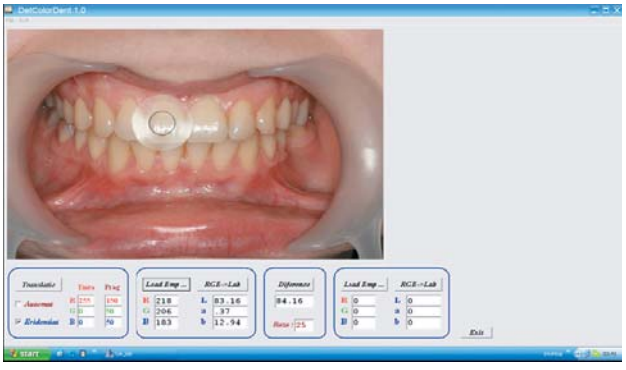

Fig. 4. L_1*, a_1*, b_1* values determination using **DetColorDent 1.0** software.

The Vita Easy Shade spectrophotometer (Vita, Germany), was use as control. The same 6 mm^2 area from the tooth 1.1 was measured (Fig. 5). A second set of values, L_2*, a_2*, b_2* were obtained (Fig. 6).

Fig. 5. Positioning the Spectrophotometer.

Fig. 6. L_2*, a_2*, b_2* control values determination using the spectrophotometer.

The control L_2*, a_2*, b_2* values obtained with the spectrophotometer were compared with the data obtained from the computer analysis of the 4 digital images taken for each patient.

The **ΔE** * calculation was made using the same DetColorDent 1.0. software (fig. 7).

ΔE* was obtained using the formula:

$$\Delta E^* = ((L_2^*-L_1^*)^2 + (a_2^*-a_1^*)^2 + (b_2^*-b_1^*)^2)^{1/2}$$

Were: L* lightness value, a* red - green axis value, b* yellow – blue axis value.

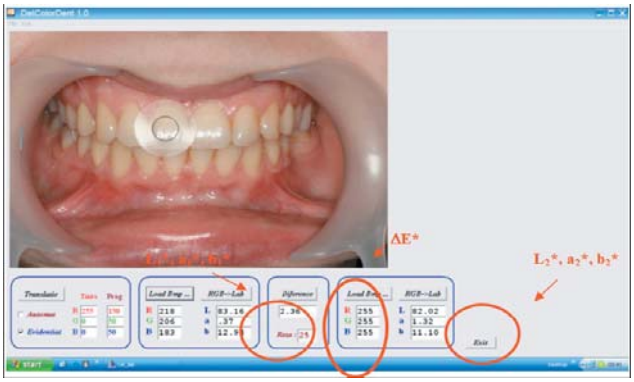

Fig. 7. ΔE* calculation.

Four **ΔE*** values (ΔE_A, ΔE_B, ΔE_C, ΔE_D) were obtained for each patient, values < 3.4 were considered clinically acceptable.

The results were statistically analyzed using the SSPS 13.0 for Windows - Mann Whitney test.

Results

ΔE calculated with the above formula are themselves a statistical evaluation through their mathematical distance. We made the statistical analysis by comparing the means and the medians of these distances for the 4 illumination settings of the flash.

The ΔE* values obtained were situated in the interval 2.99-25.68. The highest number of ΔE values lower than 3.4 were obtained for the exposure compensation setting 'C' (56%). For this case, the mean value of ΔE^*_C was 5.43±2.46, CI 95% = [4.41; 6.44]. There was a significant statistical difference between ΔE^*_C and the next median ΔE^*_D (p=0,001 Mann Whitney test – SPSS 13.0), and also to - ΔE^*_A, ΔE^*_B, ($p \leq 0.001$).

Discussions

Obtaining the correct exposure of the photographed teeth is one of the main issue for obtaining natural colors rendition [1].

Using the Canon 400D camera with the MR-14EX flash, having TTL II metering system, we tried to have good lightning conditions for the images we obtain, capable to generate results close to the control group, obtained with the spectrophotometer measurements.

The photographic system we used for this study use the TTL II metering system for controlling the exposure. These systems use a preflash, which is just a fire before main flash. The camera determine correct exposure on the basis of the reflected light metering of the preflash falling onto the outer surface of the shutter and adjust the amount of light necessary for the suitable exposure with the second flash (main flash). Since the camera 'does not know' what is photographing a mid – range exposure is selected corresponding to a medium gray level [3]. Teeth had very bright highlights; the exposure in the rest of the image is reduced so that the overall exposure is equal to that of the subject with medium reflectivity. For that reason, an image of a dental arch can likewise be too dark. This must be taken into consideration and can be corrected by using the exposure compensation setting.

For color analysis in CIELAB color space, we developed a computer software. We didn't use common color analysis software (ex: Adobe Photoshop), who works with a different L* scale (0-256), rather the one use by the spectrophotometers (0-100) [3,6].

In our study we obtained images which relived natural color of the teeth mostly for exposure compensation 'C' (56%, $\Delta E^* < 3,4$), correspondent to +2/3 value. Our results are similar with the literature considerations, indicating +2/3 of a stop, the most indicated setting of exposure compensation in intraoral photography [2]. The results indicated that the correct exposure in still difficult to achieved in oral photography.

Conclusions

The study, demonstrate the difficulty in obtaining digital images with natural teeth color characteristics.

The digital images obtained by using camera Canon 400D revealed natural color mainly for the exposure compensation setting 'C'.

The digital camera can be used for color measurements in the dental clinic dentistry.

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