Brazilian Dental Science
Ciência Odontológica Brasileira
unesp
UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

ORIGINAL ARTICLE

doi: 10.14295/bds.2016.v19i3.1270

# Accuracy of color measurement of endondontically treated teeth after aging

Precisão da medição de cor de dentes tratados endodonticamente após envelhecimento

**Tatiana PEREIRA-CENCI[1], Jovito Adiel SKUPIEN[1], José Augusto SEDREZ-PORTO[1], Álvaro Della BONA[2], Marcos JACOBOVITZ[3], Fernanda Geraldo PAPPEN[1]**

1 – Graduate Program in Dentistry - Federal University of Pelotas - Pelotas - RS, Brazil.

2 – Graduate Program in Dentistry - University of Passo Fundo - Passo Fundo - RS - Brazil.

3 – Department of Endodontics - Paulista Association of Dental Surgeons, São Carlos, SP, Brazil.

## ABSTRACT

**Objective:** The aim of this study was to compare the accuracy of three different modes of a spectrophotometer (Vita Classical, 3D-Master and CIE L*a*b* system) in the evaluation of color alteration in endodontically treated teeth. **Material and Methods:** The root canal treatment of forty-five sound human canines was performed. Color measurements were performed before the endodontic treatment (baseline), and after 6 months of water storage. Shade matching was performed using a spectrophotometer (Vita Easyshade) in three different modes: Vita Classical, 3D-Master and CIE L*a*b* coordinates. The color change (ΔE value) for the three methods were assessed in each sample and analyzed by multiple linear regression analysis. L*, a* and b* values were analyzed by t-test. The significance level was set at 5%. **Results:** According to the digital evaluation, no statistically significant differences were found between the CIE L*a*b*,Vita Classical and 3D-Mastermodes. However, a significant difference was found ($p < 0.001$) for the ΔE values, with the CIE L*a*b* mode presenting greater accuracy to detect color alterations. **Conclusion:** CIE L *a*b* method properly correlates to Vita Classical and 3D-Master modes. However, Easyshade can easier detect color changes if used in the CIE L*a*b* mode, which leads to more accurate results.

## KEYWORDS

Spectrophotometry; Tooth discoloration; Endodontically treated teeth.

## RESUMO

**Objetivo:** O objetivo deste estudo foi comparar a precisão de três modos diferentes de um espectrofotômetro (Vita Classical, 3D-Master e sistema CIE L*a*b*) na avaliação da alteração de cor em dentes tratados endodonticamente. **Materiais e Métodos:** O tratamento endodôntico de quarenta e cinco caninos humanos foi realizado. Medições de cor foram realizadas, antes do tratamento endodôntico (imediatamente), e após 6 meses de armazenamento em água. Análise de cor foi realizado utilizando um espectrofotômetro (Vita Easyshade) em três diferentes modos: Vita Classical, 3D-Master e sistema CIE L*a*b*. A mudança de cor (valor ΔE) para os três métodos foram avaliadas em cada amostra e analisados através de análise de regressão linear múltipla. Valores de L*, a* e b* foram analisados através do teste-t. O nível de significância estabelecido foi de 5%. **Resultados:** De acordo com a avaliação digital, não foram encontradas diferenças significativas entre os métodos CIE L*a*b*,Vita Classical e 3D-Master. No entanto, uma diferença significativa foi encontrada ($p < 0,001$) para os valores de ΔE, com o modo CIE L*a*b* apresentando uma maior precisão para detectar alterações de cor. **Conclusão:** O método CIE L *a*b* correlaciona corretamente para os modos Vita Classical e 3D-Master. No entanto, o Easyshade pode detectar alterações de cor, mais facilmente quando utilizado no modo CIE L *a*b*, permitindo resultados mais precisos.

## PALAVRAS-CHAVE

Espectofotômetro; Descoloração dental; Dentes tratados endodonticamente.

## INTRODUCTION

Changes in tooth color can be induced by peroxide bleaching, darkening by restorative materials or even as a result of endodontic treatment [1,2]. Thus, the identification of appropriate tooth color for monitoring and especially for the treatment of patients is quite important [3]. Color determination can be performed by visual or instrumental techniques. The first is the most widely used in clinical practice and is based on a subjective assessment using a standardized shade guide for comparison, as Vita Classical, ordered by basic hues in letters and chroma by their numbers, resulting in two dimensions of color, while Vita 3D-Master is structured to a second colorimetric selection sorting: value (lightness), chroma (intensity) and hue (tint) [4,5]. The instrumental technique employs a device i.e. a spectrophotometer, quantifying the color in three different modes, resulting in an objective and fast evaluation. Among the different existing systems of color evaluation, the CIE L*a*b* system, recommended by the Commission Internationale de L'Eclairage is one of the most commonly used [6].

Changes in optical and chromatic properties of the dentinal structure are likely to cause an alteration in the outward appearance of the crown caused by light transmission and reflecting properties [7]. Endodontically treated teeth in some cases undergo color changes immediately after endodontic treatment or over time [8]. Studies of color tooth alteration by endodontic materials are needed for conclusive results as to determine the best way to assess color in these situations [9]. The professional must be ready to perform a good clinical examination, based not only on visual perception, but also considering factors such as the patient's age, the degree of browning, the time when the tooth is darkened and the difficulty in reaching the reversal of this alteration with direct impact on the planning of dental rehabilitation [10].

It is important that the color values are consistent, offering reliability and agreement among different evaluations, avoiding errors and providing avoidable difficulties in daily clinics. Moreover, it is unknown if the instrumental technique adequately detects color changes as the shade guides, nor if a correlation between them exists [5,10,11]. Thus, the aim of this study was to compare three spectrophotometer evaluation modes (Vita Classical, 3D-Master and CIE L*a*b* system) for the evaluation of color alteration in endodontically treated teeth after 6 months of aging. The hypothesis tested was that there would be no difference among the spectrophotometer evaluated modes.

## MATERIAL AND METHODS

### *Experimental design*

This was a randomized and blind in vitro study, approved by the local research and ethics committee (Protocol #149/2010). Forty-five extracted and sound canines were selected for the study and underwent endodontic treatment. Teeth were evaluated for tooth color alteration after 6 months of water storage using three different methods available in Vita Easyshade spectrophotometer (Vita Zahnfabrik/Bad Sackingen, Germany).

### *Teeth selection and color measurement*

Forty-five teeth were included in the study. The exclusion criteria included teeth with caries or any type of defect, such as fractures, fissures and cracks. The teeth were cleansed with 1% sodium hypochlorite followed by coronal access. Teeth were then immersed in 10% hydrogen peroxide for 24h at room temperature. After biomechanical preparation, the root canal filling was performed. The root canal filling was cut 2.5 mm below the cement-enamel junction, considering the buccal aspect of the tooth. Cervical space was filled with glass ionomer cement (VitrebondTM, 3M ESPE, St. Paul, MN, USA). Next, tooth

color measurement was performed using the spectrophotometer (Vita Easyshade; Vita Zahnfabrik / Bad Saeckingen, Germany). This information was also used to select the color of composite resin restoration (Filtek Z-250, 3M ESPE, St. Paul, MN, USA). Shade readings were taken prior to the endodontic filling and 6 months after completion of endodontic treatment, with the teeth stored at 37°C in distilled water. All measurements were done in the cervical third of the buccal surface of the tooth crown, storage in water of the teeth before and immediately after the reading was performed, preventing color changes by dehydration.

### *Color calculation and data analysis*

Color was measured using the spectrophotometer using the 3 different modes. CIE L*a*b* color system was used and allowed the determination of color in the three-dimensional space: L* (Lightness, ranging from 0 to 100 with higher numbers being brighter), a* (green-red coordinate) and b*(blue-yellow coordinate). To calculate the color differences (ΔE) and lightness variations (ΔL). The spectrophotometer (Vita Easyshade; Vita Zahnfabrik / Bad Saeckingen, Germany) was also used for Vita Classical and 3D-Master shade guides to obtain the color coordinates (L*a*b*). The active point of the spectrophotometer was placed following the same characteristics of the teeth ratings. Thus, it was possible to numerically calculate the differences in color and lightness for the data at different times for the two shade guides. Color difference was obtained using the formula: $\Delta E=((\Delta L)^2+(\Delta a^*)^2+(\Delta b)^2)^{1/2}$ and difference in lightness was calculated by ΔL. The values of ΔE and ΔL obtained by the visual and instrumental techniques were analyzed by multiple linear regression and the L*, a* and b* values were analyzed by t Test in SPSS 19 for Mac software (SPSS Inc, Chicago, IL, USA) with $\alpha=0.05$.

## RESULTS

Figure 1 presents the degree of color changes (ΔE) and Figure 2 the values of the L*, a* and b* parameters using the visual and instrumental techniques. For the ΔE values, there was a correlation between Vita Classical and 3D-Master mode. However, there was a statistically significant difference between these latter and the values of CIE L*a*b* provided by the spectrophotometer. For the t Test, there was no statistically significant difference between initial and final values of L*, a* and b* for all tested conditions ($p > 0.05$).

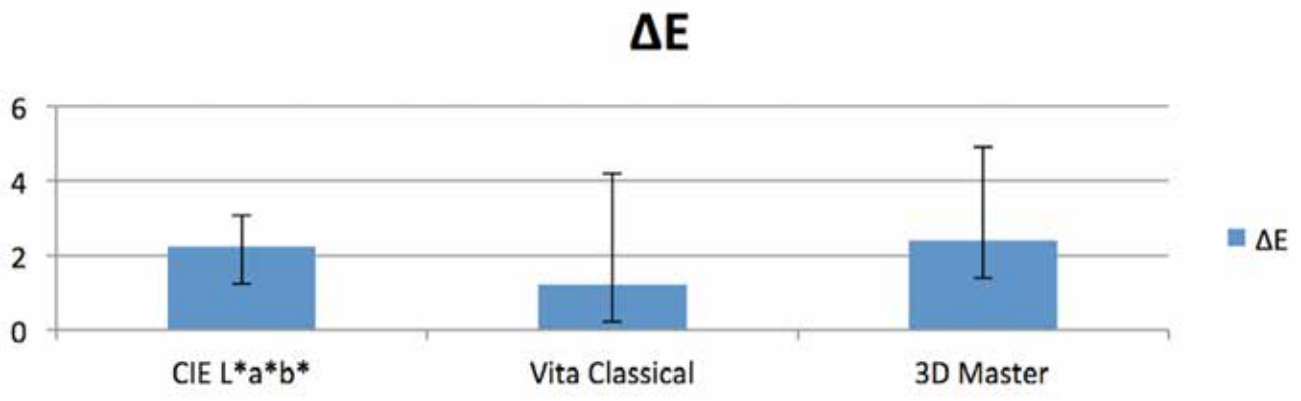


**Figure 1 -** Mean (± SD) tooth discoloration after 6 months.

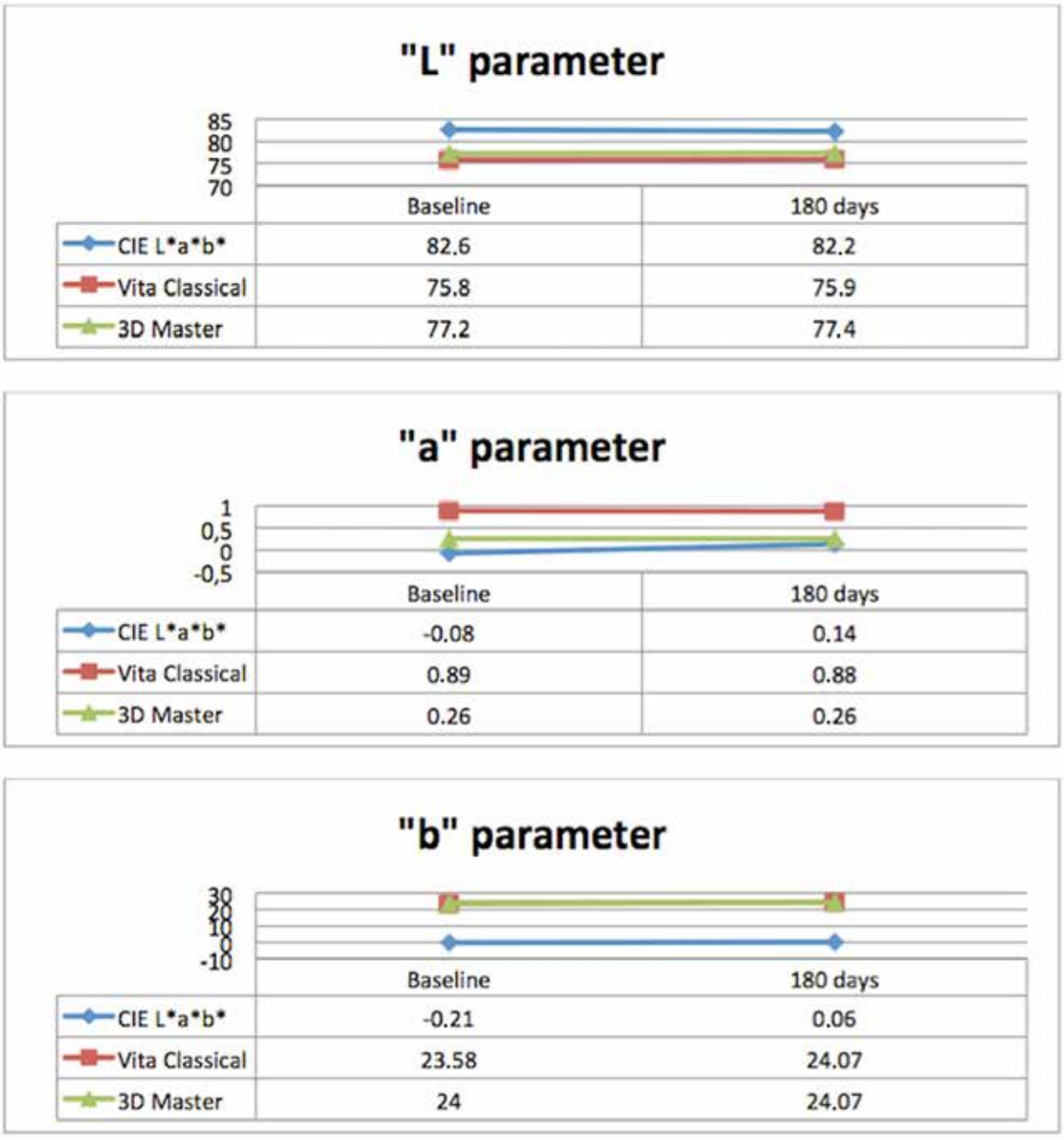


**Figure 2 -** Mean values of L*, a* and b* measurements for each color evaluation and tested time period (from baseline to 6-month after endodontic treatment).

## DISCUSSION

The null hypothesis was rejected, since there was a difference in the ΔE values among the evaluation modes. This may be explained by the greater specificity of the spectrophotometer when measuring values of L*, a* and b*, assuming moderate or pronounced discrepancy for these values already identified after the evaluation of the color of teeth [12]. However, this difference did not affect the correlation between the observed differences comparing the Vita Classical and 3D-Master modes, since a positive correlation was found between these latter and therefore, validating the use of Easyshade for this purpose. Conversely to our results, a similar study has demonstrated that

3D-Master shade guide presents superiority when compared to Vita Classical and still found a correlation when evaluating the color of ceramics [10]. This small superiority of 3D-Master shade guide contains more tabs due to the larger number of color samples with 26 options compared to Vita Classical, which provides 16 colors only. However, the higher number of 3D-Master colors becomes similar to Vital Classical through the CIE L * a * b * color system to approximate analysis [11].

When using a spectrophotometer as Easyshade, it is important to understand that the determination of the tooth shade is given as the nearest corresponding color according to the database of the device, according to an internal database [10]. This approach values can serve as confounding bias to obtain the actual data, especially when making color measurements at different times, in order to evaluate tooth lightening or darkening. This fact consolidates the importance of understanding and assessing other features as lightness that can affect the determination of aesthetic results, requiring careful measurements by the professionals, irrespective of the use of any digital device [5]. Although studies have already shown that spectrophotometers are more accurate and reproducible than the human eye, the fact that differences in values are one of the features most perceived by human eyes cannot be ignored [4,5,14]. In this study, no differences in lightness detected by the device were found, proving that the determination of color was satisfactory, irrespective of the mode selected by the spectrophotometer. In addition, it is possible to emphasize that Easyshade's reliability may serve as a viable alternative, able to help in the evaluation of color [15].

It is worth mentioning that the color change caused by endodontic treatment influenced the color choice. Studies have reported that Vita Classical and 3D-Master may be considered subjective methods, since the operator i.e. interpretation of the human eye and environmental influences on clinical examination, including fatigue, and lighting conditions may directly influence the outcome. Greater accuracy of instrumental technique, when using the CIE L*a*b* mode can be justified in this study because for the calculation of ΔE, presenting the lowest standard deviation [4]. Since the method of analysis tested in this study is considered a reliable and fast method that is not influenced by external variables during the color choice, CIE L*a*b* quickly shows tooth discoloration, with results similar to that of the traditional method [8,16].

Despite the difference between Vita Classical and 3D-Master, its clinical importance needs to be further investigated since the delta values for CIE L*a*b* mode were lower at 3.3, what is considered clinically acceptable [17]. Although it is not possible to completely relate these findings to any clinical situation, it is important to remember that the use of human teeth and all steps according to clinical practice can generate higher response variability. The correlation found between the Vita Classical and 3D-Master modes can also offer greater comfort in clinical management, but it is noteworthy that the association with shade matching guides and the use of clinical spectrophotometer can minimize errors in the evaluation of color.

## REFERENCES

1. Villalta P, Lu H, Okte Z, Garcia-Godoy F, Powers JM. Effects of staining and bleaching on color change of dental composite resins. J Prosthet Dent. 2006;95(2):137-42.
2. Meincke DK, Prado M, Gomes BPF, Della Bona A, Sousa ELR. Effect of endodontic sealers on tooth color. J Dent. 2013;41(Suppl 3):93-6.
3. Chu SJ, Trushkowsky RD, Paravina RD. Dental color matching instruments and systems. Review of clinical and research aspects. J Dent. 2010;38(Suppl 2):12-6.
4. Meireles SS, Demarco FF, Santos IS, Dumith SC, Della Bona A. Validation and reability of visual assessment with a shade guide for tooth-color classification. Oper Dent. 2008;33(2):121-6.
5. Gómez-Polo C, Gómez-Polo M, Celemin-Viñuela A, Martínez Vázquez De Parga JA. Differences between the human eye and the spectrophotometer in the shade matching of tooth colour. J Dent. 2014;42(6):742-5.
6. Commission Internationale de l'Eclairage: Colorimetry, ed 2, CIE Publication No. 15.2, Paris, 1986, Central Bureau of the CIE.

7. Ioannidis K, Mistakidis I, Beltes P, Karagiannis V. Spectrophotometric analysis of crown discoloration induced by MTA- and ZnOE-based sealers. J Appl Oral Sci. 2013;21(2):138-44.

8. Partovi M, Al-Havvaz AH, Soleimani B. In vitro computer analysis of crown discolouration from commonly used endodontic sealers. Aust Endod J. 2006;32(3):116-9.

9. Krastl G, Allgayer N, Lenherr P, Filippi A, Taneja P, Weiger R. Tooth discoloration induced by endodontic materials: a literature review. Dent Traumatol. 2013;29(1):2-7.

10. Corciolani G, Vichi A, Goracci C, Ferrari M. Colour correspondence of a ceramic system in two different shade guides. J Dent. 2009;37(2):98-101.

11. Zenthöfer A, Wiesberg S, Hildenbrandt A, Reinelt G, Rammelsberg P, Hassel AJ. Selecting VITA classical shades with the VITA 3D-master shade guide. Int J Prosthodont. 2014;27(4):376-82.

12. Khashayar G, Dozic A, Kleverlaan CJ, Feilzer AJ. Data Comparison Between two dental spectrophotometers. Oper Dent. 2012;37(1):12-20.

13. Yuan JC, Brewer JD, Monaco EA Jr, Davis EL. Defining a natural tooth color space based on a 3-dimensional shade system. J Prosthet Dent. 2007;98(2):110-9.

14. Paul S, Peter A, Pietrobon N, Hämmerle CH. Visual and spectrophotometric shade analysis of human teeth. J Dent Res. 2002;81(8):578-82.

15. Della Bona A, Barrett AA, Rosa V, Pinzetta C. Visual and instrumental agreement in dental shade selection: three distinct observer populations and shade matching protocols. Dent Mater.2009;25(2):276-81.

16. Polydorou O, Hellwig E, Hahn P. The efficacy of three diferente in-office bleaching sytems and their effect on enamel microhardness. Oper Dent. 2008;33(5):579-86.

17. Ruyter IE, Nilner K, Moller B.Color stability of dental composite resin materials for crown and bridge veneers. Dent Mater. 1987;3(5):246-51.

**Fernanda Geraldo Pappen**
**(Corresponding address)**
R. Gonçalves Chaves, 457,Pelotas, RS, Brazil 96015-560
e-mail: ferpappen@yahoo.com.br
Tel/Fax: 32256741 ext. 134

Date submitted: 2016 May 02

Accept submission: 2016 Aug 07