J Oral Res
research in oral sciences

Review

Selection of tooth colour using spectrophotometry and a visual method. A Literature Review.

Selección de color dentario utilizando espectrofotometría y método visual. Revisión Bibliográfica.

Alejandro Avendaño Arenas.[1]
Carlos Astorga Gallardo.[1]
Verónica Cabezas Osorio.[1]

Affiliations:
[1]Facultad de Odontología, Universidad de Concepción, Chile.

Corresponding author: Verónica Cabezas Osorio. Facultad de Odontología, Universidad de Concepción, Chile. Avenida Roosevelt 1550, Concepción, Chile. Phone: (56-41) 2204232. E-mail: vcabezas@udec.cl

Receipt : 06/23/2021
Acceptance : 08/25/2021

Cite as: Avendaño Arenas A, Astorga Gallardo C & Cabezas Osorio V. Selection of tooth colour using spectrophotometry and a visual method. A Literature Review. J Oral Res 2021; S-1 (Congreso):1-4. Doi:10.17126/joralres.2021.041

INTRODUCTION.

The demand for esthetic dentistry in clinical practice has been steadily increasing. When a dental piece is rehabilitated, it is very important to restore both the morpho-functional characteristics as well as the aesthetic appearance. Patients consider color as a fundamental criterion for the success of rehabilitation; therefore, dental chromatics must be known and understood since discordant color can mean the failure of an aesthetic result.[1]

Color measurement is usually done visually, comparing teeth to standardized color guides, according to the Munsell color space system in terms of color tone (hue), color value (lightness), and color chroma (intensity). Tone is the first dimension of color, and it is related to the perception of wavelengths of light. It is the characteristic that differentiates some colors from others.

Color value is possibly the most important dimension in dentistry. It is defined by the amount of black and white within a scale, which is related to lightness/darkness; and finally, the intensity represents the degree of saturation, that is, the amount of color existing in the tooth. Improved color guides, the availability of color devices, and research inhuman color vision have enhanced the potential to achieve excellent color-matched restorations.

Currently available methods for tooth color selection can be divided into two main categories: visual and instrumental. However, the first method can lead to error when evaluating tooth color and/or tooth restoration .[1-3] The objective will be to compare the results using a visual method and a spectrophotometry in the color selection performed by dental surgeons according to various studies.

ISSN Print 0719-2460 - ISSN Online 0719-2479.

MATERIALS AND METHODS.

The *PubMed* and *SciELO* databases were used, obtaining a total of 1435 articles, with the keywords: spectrophotometer, tooth color, dental aesthetics.

The inclusion criteria were the following:

- All the articles related to tooth color selection.
- Comparative studies between visual and spectrophotometry methods.
- Systematic reviews of tooth color assessment.
- Less than 5 years old articles.

Systematic reviews and human clinical trials in Spanish and English were included. These were downloaded, and after reading the abstracts of 42 articles, 13 were selected.

RESULTS.

Color is a physical phenomenon of visual perception, related to the different wavelengths in the visible area of the electromagnetic spectrum, and is the consequence of the combination of three factors: reflected and transmitted light, the object, and the observer. Thus, tooth color cannot be considered a stable parameter, but rather varies from one individual to another, from one dentition to another, from one tooth to another, and even over time within the same tooth.[4]

Comparative studies agree that a potential advantage is offered by the instrumental method over the visual method in color selection and highlights students and even experienced professional are less likely to correctly select tooth color using the visual method compared with using the spectrophotometer. The spectrophotometer used in the studies was EasyShade, which showed higher levels of agreement than other instruments.[1,4,5]

The Ishihara test should be carried out to exclude subjects with visual alterations in the selection of colors, which allows for the detection congenital protan and deutan defects through the observation of images, and therefore alterations in the determination of colors.[6]

Tone is the first dimension of color and is related to the perception of wavelengths of light. It is the characteristic that differentiates some colors from others. The value of a color is possibly the most important dimension in dentistry and is defined by the amount of black and white within a scale, which is related to lightness/darkness; and the intensity represents the degree of saturation, that is, the amount of color existing in it.[2]

DISCUSSION.

Frequently, the human eye determines that the colors of two teeth match each other, even though one of the teeth has more value. However, outside the clinic, sometimes the result is not as expected.[7]

Determining tooth color correctly is an essential treatment step in aesthetic reconstructive dentistry. Factors such as lighting conditions, gender, age, experience, and the observer's impaired vision all affect the tone matching process.[8] The various lighting conditions can increase the subjectivity in determining color visually, and not with the spectrophotometer, which works by measuring the light energy reflected from objects in intervals of 1-25 nanometers (nm) of the visible spectrum which has a record that is obtained in the three-dimensional coordinates of the CIELAB system. Basically, light is emitted, and its reflection is measured. Measurements last less than a second and are not noticeable by the patient.[2,3,9]

The spectrophotometer is used to measure and is based on wavelengths. The use of this type of device has several advantages; it saves time, it is accurate in color evaluation, it has a short adaptation period, it obtains objective results (independent of lighting and the user) and it has the possibility of standardizing and reproducing the recorded data.

The most frequently applied method in dentistry, despite its subjective method to determine color, is visual determination that compares the tooth with the standard color of the tooth color guides. This is a subjective process whereby the tooth and the color guide are viewed simultaneously under the same lighting conditions. General variables such as external light conditions, experience, age, and human eye fatigue can lead to inconsistencies.[5,8,9]

The 3D Master Color Guide, which is the most widely used, was introduced on the market in 1998 with the purpose, according to its manufacturer Vita-Zahnfabrik, of covering the color space of natural teeth. It is based on the three-dimensional color

model and is currently the only color guide on the market capable of scientifically determining color by selecting each of the three-color dimensions individually, in order of value or lightness, intensity and tint.

Five different levels of lightness are used to create five groups of color slats, from 1 (lightest) to 5 (darkest).

In turn, there are three levels of intensity, from 1 (least saturated) to 3 (most saturated) in each group. The saturation or intensity levels (1.5 and 2.5) in groups 2, 3 and 4 are associated with tint or tone variations - L (yellow) and R (red).[1,2,10]

Although the color of the marketed guides is standardized, they could vary due to parameters that are difficult to control during their manufacture, such as coating, layer thickness, and sintering. However, despite this lack of certainty, the visual color guides are currently the most used means to determine color in Dentistry.[11] When measuring the color of teeth, all the authors agree that a tooth is not monochromatic and that the middle third is the most representative area of the tooth. This is since the incisal third is very translucent, so its color perception is affected by its background, and the color of the cervical third is influenced by the proximity of the gingival margin.[10-12]

Currently, visual color selection is still the method most used by dentists, but according to several studies, measurements by spectrophotometer allow for readings that are objective and quantifiable.[13]

CONCLUSION.

The appearance and color of teeth is a complex phenomenon, that involves many factors, such as lighting conditions, light scattering, translucency, and opacity of the tooth structure. It is critical because small differences in color can make patients dissatisfied with the results. The incorporation of digital technology in the selection of color by means of a spectrophotometer allows an objective and quantifiable measurement to be achieved. Despite the frequent use of standardized color guides, which have aided in this selection, operator observation remains a subjective method, which can be misleading.

Literature shows how the measurement with a spectrophotometer is more precise and reproducible than that achieved by the human eye. The main disadvantage of these devices compared to traditional visual methods would be the financial cost of the devices, which is the reason their use is yet little integrated into daily practice. However, the benefits they deliver allow to achieve an optimal result.

ISSN Print 0719-2460 - **ISSN Online** 0719-2479.

REFERENCES.

1. Bofill-Fonbote, Sofía, Crisóstomo-Muñoz, Javier, Pavez-Ovalle, Francisco, Brunet-Echavarría, Jacqueline y Valenzuela-Aránguiz, Vladimir Selección de color dentario: comparación de los métodos visual y espectrofotométrico. Rev Clin Periodoncia Implantol Rehabil Oral (PIRO). . 2016;9(2):163-167. Disponible en: https://www.redalyc.org/articulo.oa?id=331047133013
2. Schmeling M. Selección de color y reproducción en Odontología. Parte 3: Escogencia del color de forma visual e instrumental. Int J Dental Sc 2017;19(1) :23-32.
3. Ristic I, Stankovic S, Paravina RD. Influence of Color Education and Training on Shade Matching Skills. J Esthet Restor Dent. 2016 Sep;28(5):287-294. doi: 10.1111/jerd.12209. Epub 2016 Apr 7. PMID: 27061853.
4. Pecho OE, Ghinea R, Alessandretti R, Pérez MM, Della Bona A. Visual and instrumental shade matching using CIELAB and CIEDE2000 color difference formulas. Dent Mater. 2016 Jan;32(1):82-92. doi: 10.1016/j.dental.2015.10.015. Epub 2015 Nov 28. PMID: 26631341.
5. Kröger E, Matz S, Dekiff M, Tran BL, Figgener L, Dirksen D. In vitro comparison of instrumental and visual tooth shade determination under different illuminants. J Prosthet Dent. 2015 Dec;114(6):848-55. doi: 10.1016/j.prosdent.2015.06.004. Epub 2015 Sep 4. PMID: 26346420.
6. Olms C, Jakstat HA, Haak R. The Implementation of Elaborative Feedback for Qualitative Improvement of Shade Matching-A Randomized Study. J Esthet Restor Dent. 2016 Sep;28(5):277-286. doi: 10.1111/jerd.12231. Epub 2016 Aug 17. PMID: 27534729.
7. Arias R, González I, Estay J, Bersezio C, Jara A, Angel P. Entrenamiento de la capacidad de discriminación visual en odontología. Rev Fac Odontol Univ Antioq 2015; 26(2): 358-367.
8. Wee AG, Meyer A, Wu W, Wichman CS. Lighting conditions used during visual shade matching in private dental offices. J Prosthet Dent. 2016 Apr;115(4):469-74. doi: 10.1016/j.prosdent.2015.09.020. Epub 2015 Dec 23. PMID: 26723088.
9. Gomez C, Gomez M, Montero, Martinez J, Celemin A. La correlación de color del diente natural con el envejecimiento de la población española. Diario Internacional de Odontología 2015; 65: 227 – 234
10. Hein S, Tapia J, Bazos P. eLABor_aid: a new approach to digital shade management. Int J Esthet Dent. 2017;12(2):186-202. PMID: 28653050.
11. Sánchez NM. La Importancia de la Selección del Color en la Práctica Odontológica. Psychologia Latina. 2018; 330-333
12. Alfouzan AF, Alqahtani HM, Tashkandi EA. The Effect of Color Training of Dental Students' on Dental Shades Matching Quality. J Esthet Restor Dent. 2017 Sep;29(5):346-351. doi: 10.1111/jerd.12284. PMID: 28127849.
13. Olms C, Jakstat HA, Haak R. The Implementation of Elaborative Feedback for Qualitative Improvement of Shade Matching-A Randomized Study. J Esthet Restor Dent. 2016;28(5):277-286.