journal of dentistry 41s (2013) e3–e10

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/jden

Developing a custom dental porcelain shade system for computer color matching

Shigemi Ishikawa-Nagai [a], *Jian Wang* [a,b], *Alison Seliger* [a], *Jin Lin* [a], *John Da Silva* [a,*]

[a] *Department of Restorative Dentistry and Biomaterials Sciences, Harvard School of Dental Medicine, Boston, MA, United States*
[b] *Department of Prosthodontics, West China College of Stomatology, Sichuan University, Chengdu, Sichuan, PR China*

ARTICLE INFO

Article history:
Received 29 March 2012
Received in revised form
12 November 2012
Accepted 16 December 2012

Keywords:
Shade
Computer colour match
Dental porcelain

ABSTRACT

Objectives: This study aims to update the computer color matching method by generating a new ceramic shade system that covers the entire spectrum of natural tooth color and has an efficient design.
Methods: First, the color map of 176 maxillary natural incisors and two commercially available and commonly used shade guide systems (Vitapan classic and 3D master) were drawn. Then, 15 shades of layered disks (NW-0: neutral white-0, A1, A2, A3, A4, B1, B4, C4, and D4, and six modifiers; white, pink, grey, blue, cervical-1 and cervical-2, Cerabien ZR) were plotted on the tooth color distribution map. Ultimately, 12 target shades were selected around the perimeter of the natural tooth color space, and nine different shades were selected within the cluster. By trial and error informed by known formulations published previously, the formulations of Cerabien ZR porcelain powders necessary to achieve these 21 target shades in thickness of 1.0 mm layered on zirconia substrate were then determined and ceramic disks were fabricated.
Results: Color distribution L^*–C^* and a^*–b^* maps showed that new 21 shade system covers a slightly broader range than the natural tooth distribution, and its distribution is larger than the 3D Master shade's range.
Conclusions: In the present study, a 21 custom dental porcelain shade system was developed with a 1.0 mm porcelain thickness overlying a zirconia substrate, which can be incorporated into the computer color matching system. This new shade system has homogeneity with 3D Master, and has a slightly wider color distribution than that of natural teeth.
© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

With all of the advances in clinical dentistry over the past decades, methods for matching the color of ceramic restorations to the color of natural teeth have been largely unchanged. Dental shade guides remain the most common method for matching tooth color in restorative and bleaching procedures. A shade guide is comprised of a set of shade tabs intended to cover the range of colors present in the human dentition. Numerous reports have indicated that commercially available shade guides do not provide sufficient spectral coverage of colors present in teeth and are not uniformly distributed throughout the color space of natural teeth.[1–4] Further, the accuracy of shade matching through visual comparison is compromised by limitations of both these shade guides and the dental practitioners.[5–7] Achievement of a clinically acceptable color match between a given tooth and a

* *Corresponding author at*: Harvard School of Dental Medicine, 188 Longwood Avenue, Boston, MA 02115, United States. Tel.: +1 617 432 1790; fax: +1 617 432 0901.
E-mail address: john_dasilva@hsdm.harvard.edu (J. Da Silva).
0300-5712/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jdent.2012.12.006

shade tab is closely related to the spectral coverage of the shade guide, the dentist's experience, and the environment. Perception of color by an observer is subjective, resulting in varied and unpredictable differences in color evaluation and matching among clinicians.[8,9] Two distinct avenues would be useful in addressing these issues: (1) objective spectrophotometric assessment and (2) the development of a new dental shade system that covers the entire spectrum of natural tooth colors and is evenly distributed in color space. However, these avenues would not address the significant discrepancy between the thickness of shade guide tabs and the thickness of ceramic restorations. Ceramic restorations are only 1.0–1.5 mm thick at most, whereas dental shade guides may be 3.0–5.0 mm thick.

In response, a novel computer color matching (CCM) system for use with dental ceramic restorations has been developed and tested at Harvard School of Dental Medicine. This CCM system is based on the Kubelka–Munk color theory and Saunderson's correction, which were originally developed to mathematically describe the color and translucency of industrial materials such as paint and plastic.[10–16] In those industries, CCM has been considered to be the most effective color matching technique for several decades.[16] In the dental field, CCM has been used in a research setting to achieve accurate color reproductions in dental restorative materials,[16–20] but it has not yet been used in clinical applications.

The CCM system developed by our research group consists of a spectrophotometer and a supporting computer program. The spectrophotometer provides reflectance values of the target shade from 400 nm to 700 nm, and the computer program is equipped with a color database of porcelain used. This CCM system can be used to accurately reproduce the color of natural teeth in ceramic restorations of any thickness and over any background substrate. The color of the natural tooth is measured by the spectrophotometer, and this data is interpreted by the CCM program. The program then generates a formulation for a ceramic mixture of 2–4 shades in specified ratios for a predetermined thickness over the predetermined background color (ceramic core). The Kubelka–Munk theory allows for the calculation of reflectance based on the layer's thickness, the background's reflectance, the absorption coefficient, and the scattering coefficient.[10,11] This CCM system is intended to provide ceramic prescriptions for the reproduction of any type of tooth color without the need for dental shade guides. Therefore, the CCM technique may be a more effective method for reproducing a tooth color than perceptual technique using the existing dental shade guide systems.

Our previous study of the CCM system indicated promising results in reproducing natural tooth color with two-layered ceramic disks, and suggested that the CCM is automated, reliable, and resistant to operator error.[20] However, in the prior study, the database for the CCM system was composed of shade data from ten existing commercial shades: eight dentine body shades (NW0: neutral white-0, A1, A2, A4, B1, B4, C4, and D4) and two modifier shades (pink and grey) (Cerabien ZR dental ceramic, Noritake Co.). These colors were not specifically designed for color reproduction with thin ceramic layers. Additionally, this database was not symmetrically distributed in tooth color space, and some shades were quite far from the entire spectrum of natural tooth shades. Therefore, in order to generate prescriptions for a wider and more inclusive range of tooth colors, a new customized shade system is needed. An expanded color range that is efficient, organized and covers the entire tooth color spectrum will allow us to create any tooth shade over a ceramic substrate for a prepared tooth. These shades are the basis for the reproduction of tooth color with CCM to allow the production of virtually any natural tooth shade. Our long-term goal is to establish an objective color matching system to be used with a dental spectrophotometer and computer calculations which provide porcelain prescriptions using a known systematic color reproduction system. This will bring color matching in dentistry to the higher level that other industrial fields have already achieved.[12,15]

The purpose of the present study is to test a new ceramic shade reference database with 1.0 mm thickness layered over the zirconia ceramic substrate that encompasses the entire spectrum of natural tooth color. This new color system is specially organized for use with the CCM, and is hypothesized to dramatically improve our ability to reproduce natural tooth color. We hypothesized that if our color system had a distribution beyond that of natural teeth, we would be able to reproduce colors with greater variance in each CIELAB color coordinate to enable the reproduction of all possible tooth color. Therefore, it would be expected that there would be a significant difference in the homogeneity of the variance in the new system when compared to currently used shade guides.

2. Materials and methods

2.1. Creation of the tooth color distribution map

2.1.1. Dental spectrophotometer

A dental spectrophotometer (Crystaleye®, Olympus, Tokyo, Japan, Fig. 1) was used in this study. This spectrophotometer uses seven light emitting diodes (LEDs) as an illumination source with 45/0° geometry. Prior to data acquisition, the instrument was calibrated using a calibration plate (Olympus, Tokyo, Japan). A single use positioning apparatus was placed on the spectrophotometer head, and then the

Fig. 1 – A dental spectrophotometer used in this study.

Download English Version:

https://daneshyari.com/en/article/6053657

Download Persian Version:

https://daneshyari.com/article/6053657

Daneshyari.com