Chromatic compatibility of two gingival shade guides with human keratinized gingiva

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Abstract

Purpose: To measure the validity and reliability of two gingival shade guides to represent in vivo gingival color using a Caucasian population sample. Materials and Methods: CIELab color space was used to study three gingival reference areas (the free gingival margin, the keratinized gingival body, and the upper part of the keratinized gingiva) in a sample of 259 Caucasian individuals. The color coordinates on the HeraCeram and on the IPS d.SIGN physical gingival shade guides were collected to compare with the color coordinates taken in vivo. The coverage errors of the two shade guides evaluated were calculated using CIELab, and CIEDE 2000 formula and each area of the gingiva was compared with the 50:50% acceptability threshold for $\Delta E^* = 4.6$. 

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and $\Delta E_{00}^* = 4.1$. The spectroshade spectrophotometer was used. **Results:** The IPS d.SIGN guide has similar coverage errors in all three areas and, in all cases, surpasses the 50:50% acceptability threshold. In contrast, the HeraCeram Gingiva guide has a lower coverage error in the free gingival margin than in the other two areas, and the coverage error remains below the 50:50% acceptability threshold only for $\Delta E_{00}^*$. The HeraCeram gingiva shade guide has overall coverage errors ($\Delta E^* = 7.9$ and $\Delta E_{00}^* = 5.6$) significantly lower than the coverage errors obtained for the IPS d.SIGN gingival shade guide ($\Delta E^* = 9.2$ and $\Delta E_{00}^* = 6.8$). **Conclusion:** Statistically significant differences were found in the coverage errors of both guides, both at the level of the three reference areas and at the global level. For both guides and in both sexes, the global coverage errors calculated with the CIELab and CIEDE2000 formulas were below the literature data on 50:50 acceptability thresholds. *Int J Prosthodont* 2021. doi: 10.11607/ijp.7389

**INTRODUCTION**

The selection of a subjective tooth color using the shade guides has been the most used method in dentistry.\(^1\) The perception of tooth color is subjective, and several aspects can influence the shade selection: lighting, experience, gender and age of the operator, clothes and makeup of the patient, the angle of vision and the gingival color.\(^1\)-\(^5\) The shade tabs present a limited range of colors that can be used in dental restoration.\(^6\)-\(^17\) At present, several dental shade guides are available. The VITA classical\(^\circledR\) guide that consists of 16 tablets and separated into 4 groups according to their color stands out as the "gold standard". This dental shade guide has been widely studied using spectrophotometry.\(^18\)-\(^22\) Research has not reached an agreement on whether the dental color guides are reliable and if the color selection can be used in various clinical cases.
Some publications maintain that the acceptability thresholds of patients and professionals are respected.\textsuperscript{17,20,21} Other authors, however, point out that there is a significant difference between the batches of available shade guides and the lack of organization as to what the manufacturers claim and what can be found in the physical shade guides.\textsuperscript{23-26} Currently, aesthetic dentistry is considered "white esthetic", and gingival aesthetics is considered "pink esthetic".\textsuperscript{27} The "pink esthetic" has significant importance in clinical cases such as, the Miller’s Class 3 and 4 defects\textsuperscript{28} the gingival smile line, root fractures, traumatic tooth extraction, cysts or tumors in the upper anterior region.\textsuperscript{28-38} It should be noted that 80\% of the participants present a gingival smile line\textsuperscript{31}, and the gingival color is the most important reference to define a beautiful smile\textsuperscript{31,32,39}. In the clinical situations described (Figure 1), a prosthetic replacement approach can be considered. However, it may be noted that the keratinized gingiva is not monochromatic and that there are statistically significant differences between the three parts studied.\textsuperscript{39}

\textit{Figure 1: Clinical situation with bone and gingival tissue defects as a result of traumatic exodontia.}

Prosthetic restoration provides predictable results, at a lower cost both economic and biological and can reach an aesthetic level similar to that provided by surgical rehabilitation.\textsuperscript{28-38} The ideal gingival color is complicated to achieve as the color varies depending on the degree of vascularization of the gum\textsuperscript{40}. It may also be conditioned by the chronic intake of medication such as fluoroquinolones, ketoconazole or cyclophosphamide, as well as the hygiene level or tobacco consumption.\textsuperscript{41} In addition, there is no "gold standard" of gingival shade guides\textsuperscript{39}, which causes communication difficulties with the manufacturers.
The number of gingival shade guides is limited compared to the number of dental shade guides. Most gingival shade guides have fewer shade tabs in comparison to the dental shade tabs. Besides, the scarce literature published on this subject shows the inconsistencies between the color coordinates of the gingival chromatic space and the gingival shade guides and, also the gingival shade guides show a lack of chromatic order derived from spectrophotometric studies. It would be advisable to collect data on the color coordinates of the chromatic space in natural gingiva (using a spectrophotometer) and subsequently, make the physical shade tabs of the shade guides taking into account the perceptibility and/or acceptability thresholds, as well as placing them within the guide, mainly based on its brightness. The study can be used as a reference for the 3D Master Toothguide of the manufacturer Vita Zahnfabrik. This would improve the clinicians’ decision to select the right the gum color based on scientific consensus. The manufacturers’ criteria to design the gingival shade guides and the chromatic composition of each shade tab are unknown. No studies are provided of the manufacturing process of the gingival shade guides, and there is no mention of population, race, sample size, the electronic device collecting the color coordinates, or whether they are in vivo or in vitro studies. Nor was there any mention to whether each color tab of the gingival shade guide represents the patients’ gum color. This knowledge must be a priority if we want to achieve mimicry between the dental-gingival restoration and the adjacent teeth-gum.

Over time, many color specification systems and many color differences have been proposed in the literature, seeking to improve the correlation between color measurements and visual perception. In 1976, with the desire to promote uniformity in the practice of color measurement, the Commission Internationale de l'Éclairage (CIE) recommended the use of the CIELAB color specification system with the associated
color difference formula. The CIELAB color difference formula is widely spread and used in dental research. In addition, based on the CIELAB color difference formula, some of the more recent color difference formulas have been developed, in particular the CIE94 formula and the CIEDE2000 formula.

The null hypothesis of the present study considers that there was no difference in coverage error/covering color range and distribution of healthy gingiva between the shade guides Heraceram Gingiva and IPS d SIGN Ceram in relation to the three reference areas of the gingiva.

The purpose of this study was to evaluate if the gingival shade tabs (Heraceram gingival shade guide Vs d.SIGN gingival shade guide) represent adequately the colors of the three areas of the keratinized gingiva in the sample taken of the Caucasians by measuring the coverage error using the CIELAB and the CIEDE2000 formulas.

MATERIAL AND METHODS

The procurement process for in vivo measurements on the keratinized gingiva

This study was approved by the Institutional Bioethics Committee. All the participants selected (n = 259) signed the informed consent, following the ethical precepts formulated in the Helsinki Declaration of the World Medical Association on ethical principles. The selected patients met the following inclusion criteria: age between 18 and 85 years, without gingival stains, healthy keratinized gingiva, presence of the upper central incisors, a vestibular keratinized gingiva band greater than 2mm, and at least one tooth present adjacent to the right and left of the selected upper central incisor. SpectroShade spectrophotometer (MHT Optic Research, Niederhasli, Switzerland) previously calibrated according to the manufacturers’ instructions was used to obtain the color coordinates. Three reference points were selected for
performing the chromatic measurements for each tooth, within the 5 mm vestibular keratinized gingiva band\textsuperscript{46-48} in the middle vestibular area (zenith) of the tooth (Figure 2).

Lower reference area (Zone 1): Vestibular (zenith) 0 - 1 mm corresponding to the free gingival margin.

Middle reference area (Zone 2): Vestibular (zenith) 2 - 4 mm, attached gingiva above the gingival margin. (middle section of the attached gingiva)

Upper reference area (Zone 3): Approximately 5 mm of gingiva attached above the gingival margin (upper part of the attached gingiva).

\textit{Figure 2: Measuring points distributed along the keratinized gingiva}

Three repeated measurements were performed, with the "Angle Control System" (all images were selected when the image was centred with the green-lined frame and the icon displayed on the device screen) to guarantee the correct measurement of the three selected areas according to the manufacturers’ instructions.\textsuperscript{49-52} (Fig.2) All color coordinates were taken according to the CIELAB formula (L*, a* and b*) and were registered by a 38-year-old female dentist with 15 years of experience in measuring dental and gingival color. The environmental conditions remained uniform during the study: the same dental cabinet, ambient lighting with fluorescent illumination with a color temperature that provided a 'daylight' illumination (TLD 95) of 5000-5500\textdegree K.\textsuperscript{53-54}

\textit{Description of the two gingival guides used in the study}

The CIELAB color coordinates of the 259 participants were compared with two gingival shade guides: the IPS d.SIGN Ceram and the Heraceram Gingiva (Figure 3).
The selected gingival shade guides were: the IPS d.SIGN Shade Guide from the manufacturer Ivoclar Vivadent (10 physical shade tabs) and the Heraceram Gingiva shade guides from the manufacturer Heraeus Kulzer (14 physical shade tabs). Both are the main manufacturers of pink porcelain in dentistry. The IPS d. SIGN shade guide is designed for fluorapatite-containing glass-ceramics and has 5 regular colors (G1, G2, G3, G4 and G5) and the so-called 5 intensive colors which are used to modify, at convenience, the regular color and thus approach the final color desired as much as possible. The Heraceram shade guide is composed of 6 basic colors (G2, G4, G5, G6, G7 and G8). In addition, it offers the possibility of a direct chromatic comparison with a 50% blend of the previous porcelains. The shade guide also provides 5 more colors (G2-G4, G4-G5, G5-G6, G6-G7, G7-G8) and three dyes (pink, Stain G7 and Stain G8). According to the manufacturer the guide is used for both porcelain and zirconium metal restorations.

Figure 3: IPS d.SIGN Ceram Gingival Shade Guide (10 physical shade tabs) and the Heraceram Gingiva shade guides (14 physical shade tabs)

The L *, a * and b * color coordinates of each shade tab of the IPS d.SIGN Ceram Gingival shade guide (10 shade tabs) and the Heraceram Gingiva shade guide (14 shade tabs) were measured three times. The color coordinates of each physical shade tab were obtained with fluorescent light that provided daylight illumination of 5000-5500ºK, in a gray environment and measured by the same operator (38 years old woman with 15 years of experience). The spectrophotometer (Spectroshade -MHT Optic Research, Niederhasli, Switzerland) was calibrated according to the manufacturers' instructions before each color coordinate was registered.

Evaluation of the two shade guides in each zone
The coverage error in all areas for both gingival shade guides was evaluated in the study population using the CIELab ($\Delta E^*$) and the CIEDE2000 ($\Delta E00^*$) formula (CE$_\text{CIELab}$ and CE$_\text{CIEDE2000}$). The color difference between the measurement of each participant $I$ ($i = 1, ..., 259$) and the shade tab $J$ of one shade guide was calculated in each zone $k$ ($\Delta E_{ij}^k, k = 1, 2, 3$) and the shade tab with the smallest color difference was identified. Subsequently, the coverage error in the zone $K$ was calculated as the mean value of the smallest color difference of all participants ($n = 259$), as follows:

$$CE^k = \frac{\sum_{i} \min_{j} \Delta E_{ij}^k}{n}, \quad k = 1, 2, 3$$

In the formula mentioned above the color difference between each participants’ measurements and the shade tab was evaluated using both the CIELab ($\Delta E^*$) and the CIEDE2000 formula ($\Delta E00^*$). Both for the CIELab and the CIEDE2000 formula were obtained coverage errors ($CE^k_{\text{CIELab}}, CE^k_{\text{CIEDE2000}}$, respectively).

The CIELab color difference formula was calculated as follows:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

The CIEDE2000 color difference formula provided by Sharma was calculated using an Excel spreadsheet. The calculations were realized in the total sample, and the subsample of males and females. An independent t-test and Duncan' multiple range test was performed to analyze the data.

**Global evaluation of the two shade guides**

Overall assessment of both gingival shade guides was performed, and a global coverage error was calculated as follows:

First, the global color difference was obtained between the measurement of each participant $I$ ($i = 1, ..., 259$) and the shade tab $J$ of one shade guide as follows:
\[ \Delta E_{ij}^{\text{global}} = \max_k(\Delta E_{ij}^k), \text{ with } k = 1, 2, 3; \]

Second, the global coverage error of the evaluated shade guide was calculated using the formula as follows:

\[ CE^{\text{global}} = \frac{\sum_i \min_j \Delta E_{ij}^{\text{global}}}{n} \]

The global coverage errors were calculated with the CIELab and CIEDE2000 formula \((CE_{\text{CIELab}}^{\text{global}}, CE_{\text{CIEDE2000}}^{\text{global}})\), depending on whether the color differences were evaluated using the CIELab formula or the CIEDE2000 formula.

In addition, the shade distribution was calculated for each shade tab of a particular shade guide as a shade frequency percentage of any shade tab to achieve the best global match in the sample of the participants.

The global coverage errors and the shade frequency percentages for the CIELab and CIEDE2000 formula were obtained of the total sample and the subsample of males and females. An independent t-test and a chi-squared test for homogeneity were used to analyze the data. A Kappa coefficient\(^{57}\) was measured to compare the CIELab and CIEDE2000 shade frequency percentages in each group.

**RESULTS**

The sample (n = 259) consisted of 127 men and 132 women and distributed homogeneously according to age \((\chi^2 = 5.564, p = 0.062)\). The \(L^* a^* b^*\) coordinates of the participants compared to the IPS d.SIGN Ceram and Heraceram Gingiva shade guide. See Figure 4. Coverage errors in the three zones, for the evaluated gingival shade guides. See Table 1.
For IPS d.SIGN Ceram gingival shade guide, there are not significant differences between coverage errors in the three zones (CIELab: F=0.850, p=0.428; CIEDE2000: F=0.569, F=0.566, p=0.566). By contrast, for Heraceram Gingiva shade guide, there are significant differences between coverage errors in the three zones (CIELab: F=7.181, p=0.001; CIEDE2000: F=6.457, p=0.002), being the CIELab (CIEDE2000) coverage error in zone 1 smaller than the CIELab (CIEDE2000) coverage errors in zones 2 and 3, which do not differ among them significantly.

For IPS d.SIGN Ceram gingival shade guide, the CIELab color difference coverage errors of males and females differ significantly in all the zones (zona 1: t=2.116, p=0.035; zona 2: t=2.691, p=0.008; zona 3: t=4.238, p<0.001) whereas the CIEDE2000 color difference coverage errors of males and females differ significantly in zones 2 and 3 (zone 2: t=2.043, p=0.042; zone 3: t=3.768, p<0.001) but not in zone 1 (t=1.680, p=0.094). For Heraceram Gingiva shade guide, the CIELab color difference coverage errors of males and females differ significantly in zones 2 and 3 (zona 2: t=-2.653, p=0.008; zona 3: t=-2.002, p=0.046) but not in zone 1 (t=-1.152; p=0.250), whereas the CIEDE2000 color difference coverage errors of males and females only differ significantly in zone 2 (t=-2.266, p=0.024).

In the three zones, there are significant differences between the CIELab color difference coverage errors of the two evaluated guides (zone 1: t=9.139, p<0.001; zone 2: t=4.610, p<0.001; zone 3: t=6.392, p<0.001). The same can be said about the CIEDE2000 color difference coverage errors of IPS d.SIGN gingival shade guide and Heraceram Gingiva shade guides (zone 1: t=11.466, p<0.001; zone 2: t=7.252, p<0.001; zone 3: t=8.666, p<0.001).

Global coverage errors for the two evaluated guides are presented in Table 2, which also present the shade distribution (as frequency percentages) for each shade tab.
For IPS d.SIGN Ceram gingival shade guide, the CIELab color difference global coverage errors of males and females differ significantly (t=2.260, p=0.025), but not the CIEDE2000 color difference global coverage errors of males and females (t=1.780, p=0.076). The same thing happens in the case of Heraceram Gingiva shade guide: the CIELab global coverage errors of males and females differ significantly (t=-2.211, p=0.028), but not the CIEDE2000 color difference global coverage errors of males and females.

In the comparison of both guides, there are significant differences between the CIELab color difference global coverage errors of the two evaluated guides (t=5.731, p<0.001) and the same can be said about the CIEDE2000 color difference global coverage errors (t=7.089, p<0.001).

With regard to the comparison of shade distributions in males and females, for IPS d.SIGN Ceram gingival shade guide there are significant differences both in CIELab shade distributions ($\chi^2=16.535, p=0.021$) and in CIEDE2000 shade distributions ($\chi^2=21.653, p=0.003$). By contrast, for Heraceram Gingiva shade guide there are not significant differences neither in CIELab color difference shade distributions ($\chi^2=15.063, p=0.058$) nor in CIEDE2000 color difference shade distributions ($\chi^2=13.873, p=0.179$).

In the comparison of the CIELab color difference and CIEDE2000 color difference shade frequency percentages in the total sample, kappa coefficient was 0.586 (95% CI: from 0.513 to 0.659), for IPS d.SIGN Ceram, and 0.547 (95% CI: from 0.473 to 0.620), for Heraceram Gingiva shade guide.

**DISCUSSION**
The limitations of the study are influenced by the color coordinates of the reference population, which belong to a single country and a single race and since two gingival shade guides have been used. Each manufacturer designs and manufactures physical shade tabs that are available to make a direct comparison between the adjacent gingival tissue and the area to be replaced. The Heraceram color guide provides a physical sample, three dyes, and the possibility to mix some porcelain colors on a 50% basis (G2-4 / G4-5 / G5-6 / G6-7 / G7-8), which increases of the number of physical gingival colors available. The stains and colors available at Ivoclar Vivadent and Heraeus Kulzer can modify the regular color or the mixture in different proportions and percentages of the porcelain and/or porcelains selected. This entails a wide range of chromatic possibilities that have not been studied, as they are difficult to control for the dental technician and for the clinician. The study aims to examine the dentists’ possibilities to choose the gingival color from a chromatic range offered by the physical gingival guides and have an immediate visual comparison to select a subjective color. A similar study of Sarmast et al.\textsuperscript{43} in 2018, of 5 gingival color guides, finds the worst coverage error in the IPS d.SIGN guide (Ivoclar Vivadent) $\Delta E* = 7.3$ and $\Delta E00* = 5.3$. The result is almost identical to the one found in this study $\Delta E* = 7.1$ and $\Delta E00* = 5.2$ in the middle section of the keratinized gingiva. According to both formulas, the present results show that the color frequency percentage of both formulas for the IPS d.SIGN is the base color G4, and that the color G2 hardly matches and is near 0%. In addition, a global assessment of the keratinized gingiva with the IPS d.SIGN Ceram gingival shade guide show that the color difference with both the CIELab ($\Delta E*$) as the CIEDE2000 formula ($\Delta E00*$), show coverage errors ($\Delta E* = 9.2$ and $\Delta E00* = 6.8$) that exceed the 50: 50% acceptability threshold used in the interpretation of results ($\Delta E* = 4.6$ and $\Delta E00* = 4.1$). The same occurs when men and women are studied separately ($\Delta E* =$...
9.6 and $\Delta E_{00} = 7.0$) ($\Delta E^* = 8.8$ and $\Delta E_{00}^* = 6.5$). The results do not show whether the color of the keratinized gingiva changes with age, although most of the authors do not find statistically significant differences in the age groups studied $^{39,42,52,58}$. The impact of gender on the gingival color is supported by several scientific reports $^{39,52,58}$. The shade tab G4 of the IPS d.SIGN gingival shade guide is the most similar to the gum of 137 participants (52.9%) if the color difference is evaluated using the CIELab formula. The similarity matches 95 participants (36.7%) if the color difference is evaluated using the CIEDE2000 formula. The physical gingival shade tab G2, presents a percentage frequency of practically 0%. Sarmast et al found comparable results in its study $^{43}$. The classification of the participants according to the color tabs that are most similar to the gingiva using the color differences of both formulas moderately agree ($\kappa = 0.586$). The overall assessment of the Heraceram Gingiva shade guide shows that the color difference using both the CIELab and the CIEDE2000 formula, obtain coverage errors ($\Delta E^* = 7.9$ and $\Delta E_{00}^* = 5.6$) that exceed the 50: 50% acceptability thresholds, although the coverage errors are significantly lower ($p < 0.001$ for both $\Delta E^*$ and $\Delta E_{00}^*$) than the coverage errors obtained for the IPS guide d.SIGN Ceram gingival shade guide ($\Delta E^* = 9.2$ and $\Delta E_{00}^* = 6.8$). The G5-6 color tab is the best gingival match for 131 participants (50.6%) when evaluating the color difference using the CIELab formula, and the most similar to the gum of 97 participants (37.5%) if the CIEDE2000 formula is used. The gingival shade guide Heraceram shows lower coverage errors in the three areas studied with both formulas. The Heraceram guide, gingival colors shows a color frequency percentage close to 0% with both formulas on the following colors: Pink, Stain G8, G2, G4, G8, G2-G4, G7-G8. Not even the colors that the manufacturers present as base colors obtained the highest frequency percentage on the population studied. The study by Sarmast et al. $^{43}$ uses the color coordinates of
healthy keratinized gingiva provided by Ho et al in 2015.\textsuperscript{42} Ho et al, \textsuperscript{42} (n = 238) uses a
spectroradiometer (CIELAB mean coordinates L* = 52.9, a* = 23.3 and b* = 14.9) in a
sample of several races and measures a single point in the keratinized gingiva. Although
different methodologies are used to obtain the color coordinates in the study conducted
by Gómez Polo et al. 2019 \textsuperscript{39}, the average color coordinates do not differ much
(CIELAB coordinates average L* = 49.7, a* = 23.7 and b* = 15.2), in spite of the use of
spectrophotometry, Caucasian race, and three locations in the keratinized gum.
Measurement in three areas of the gingival keratinized gingiva, similar to tooth color
measurement, can be thus substantiated as statistically significant differences between
such areas are shown in previous studies.\textsuperscript{39,59} In view of the results presented, we must
reject the null hypothesis, since statistically significant differences were found in the
coverage errors of both guides, in the three reference areas studied, and also at the
global level.

The present study evaluates physical tabs of two gingival shade guides that can
be used by the dentist to make a direct subjective visual comparison with the color of
the adjacent keratinized gingiva. Therefore, it cannot be ruled out that there are
important chromatic differences between the different batches of the gingival shade
guides, a phenomenon that has already been described in the dental shade guides.\textsuperscript{60,61}
The SpectroShade spectrophotometer has been used frequently to measure both gingival
tissue and pink porcelain samples.\textsuperscript{47-51} The effect of spectrophotometry called "edge
loss" can lead to incorrect measurements in color coordinates, mainly caused by the fact
that the surface of the gum is not smooth and uniform.\textsuperscript{62-66} It is advisable to overcome
current limitations in the study of gingival color as manufacturers should describe the
process they use to create the gingival shade tabs and create a "gold standard" in
gingival color with a representative sample of different races measured with a
spectrophotometer and a standardized methodology. Otherwise, every manufacturer creates insufficient shade tabs in both number and natural gingival color coordinates, leading to a lack of mimicry and patients’ dissatisfaction. There is a need to improve the gingival shade guides in order to make a subjective color choice with sufficient guarantees of chromatic mimicry. The threshold used for the interpretation of the results is the 50: 50% acceptability threshold of the CIELab* = 4.6 and CIEDE2000* = 4.1 formula, was used as a reference in similar studies. To this effect, it is important to highlight the lack of studies to establish the perceptibility and acceptability thresholds in the gingival chromatic space.

The Heraceram Gingiva shade guide shows satisfactory color compatibility with the colors of the keratinized gingiva of the participants. Separated by gender, we can qualify that the statement above is valid only in the three zones of keratinized gingiva in men, but not entirely in the case of women for whom the coverage error in zone 2 exceeds the acceptability threshold (ΔE00 * = 4.1) 50: 50%. The conclusion for the Heraceram Gingiva shade guide is different depending on which formula is used to measure the color difference. It must be noted that the CIEDE2000 formula correlates better with the colors visually perceived and is the one recommended by the CIE.

**CONCLUSIONS**

In both men and women, there were significant differences between the coverage errors of both guides in the three areas studied, with significantly lower coverage errors obtained with the Heraceram Gingiva guide than those obtained with the IPS d SIGN guide in all three areas. There were also significant differences between the overall coverage errors of both guides, with significantly lower overall coverage errors for the Heraceram guide than for the IPS d. SIGN guide. For both guides and both sexes, the
coverage errors using the CIELab and the CIEDE2000 formulas exceeded the literature data on 50-50% acceptability thresholds used as a reference in this study.

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Table 1. CIELab and CIEDE2000 coverage error values (SD) for IPS d.SIGN Ceram gingival shade guide and for Heraceram Gingiva shade guide

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Table 2. CIELab and CIEDE2000 global coverage error values (SD) and CIELab and CIEDE2000 Shade Frequency Percentages for IPS d.SIGN Ceram guide and for Heraceram Gingiva guide

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<td>0.580 (0.053)</td>
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<td>0.590 (0.053)</td>
<td>0.495 (0.054)</td>
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Figure 1: Clinical situation with bone and gingival tissue defects as a result of traumatic exodontia.
Figure 2: Measuring points distributed along the healthy keratinized gingiva \(^{39}\)
Figure 3: IPS d.SIGN Ceram Gingival Shade Guide (10 shade tabs) and the HERACERAM Gingiva shade guides (14 shade tabs)
Figure 4: Representation of the L*a*b* coordinates of the participants (n=259) compared to the IPS d.SIGN Ceram and Heraceram Gingiva shade guide. Lower reference area (Zone 1), Middle reference area (Zone 2) and Upper reference area (Zone 3).