Clinical Success of Shade Guides Arranged According to Lightness Measured Digitally

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The aim of this study was to evaluate whether the VITA Classical shade guide arranged according to lightness allows clinicians to more often obtain a shade match than with an arrangement based on hue groups. A panel of 50 students determined the shade of the maxillary right central incisors of three patients with two differently arranged and blinded shade guides under standardized conditions. The L*a*b* values of the tabs were compared with those of the teeth spectrophotometrically. There were no statistically significant differences between the two arrangements. Using the arrangement according to lightness did not result in improved correct shade selection. *Int J Prosthodont 2012;25:410–412.*

Dental shade guides have been imperative in shade determination since the 1950s. The VITA Classical shade guide (VITA Zahnfabrik) covers only 6% to 11% of the natural tooth color range[1–3] yet is still remarkably seen as the gold standard.

The standard allocation of the VITA tabs is based on four hues of increasing chroma and decreasing lightness. Human vision is more sensitive to changes in lightness than in perceived color (hue)[4]; hence, it is frequently suggested that color determination could be more successful when tabs are arranged according to lightness.[5]

The aim of this study was to evaluate whether this shade guide, arranged according to lightness (L*), allows clinicians to more often obtain a correct shade match. The hypothesis was that by rearranging a shade guide according to decreasing lightness, a correct shade would be selected more often.

Materials and Methods

The mean L*a*b* values for each tab of five VITA shade guides were determined using a SpectroShade Micro (SS) spectrophotometer (MHT) in a standardized manner at the maxillary right central incisor in a phantom arch with a black background. Then, an evaluation panel of 50 fifth year dental students independently determined the shade of the maxillary right central incisors of three patients with two differently arranged and blinded shade guides (Fig 1) under standardized conditions (D65 Munsell Cabin, VPI-40/65, GraphicLite). The color measurements of the tooth were imported into the SS software as L*a*b* values and their closest derived VITA shade code.

The L*a*b* values of the tabs chosen by the evaluation panel were then compared to the electronically determined L*a*b* values of the patients' teeth using the following equation:

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

Using Wilcoxon statistical analysis, the shortest distance to the original values of the teeth were calculated within the acceptance and perceptibility levels and correlated to both shade guide arrangements.

Results

The L*a*b* values for each tab of five VITA Classical shade guides were measured, and their means are summarized in Table 1. The two shade guides with L*a*b* values closest to the mean values were selected for clinical tooth color determination. The distribution among the tabs chosen by the evaluation panel with the conventional arrangement and the proposed arrangement for each patient is shown in Table 2. There were no statistically significant differences between the two arrangements for the three patients (patient 1: $\alpha = .754$, patient 2: $\alpha = .638$, patient 3: $\alpha = .238$).

The electronic measurements of the teeth resulted in the following color codes: C4, A2, and A1 for

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Fig 1 Two arrangements for the VITA Classical shade guide. The top row is arranged according to lightness (A1, B1, B2, A2, A3, C1, B3, D2, B4, D3, D4, A3.5, C2, C3, A4, C4), and the bottom row is the regular arrangement.

Table 1 Mean L*a*b Values for Each Shade Tab of the Five Different VITA Shade Guides

Shade tab	L*	a*	b*
A1	78.2	−0.2	15.3
B1	75.7	−0.3	14.1
B2	74.8	0.1	18.2
A2	74.2	1.4	18.8
A3	72.0	1.9	21.1
C1	71.7	0.0	15.1
B3	70.7	1.5	24.1
D2	70.4	0.5	14.0
B4	69.0	1.1	24.3
D3	68.7	1.8	18.4
D4	68.7	0.7	21.2
A3.5	68.4	2.8	23.7
C2	68.1	1.2	19.0
C3	65.8	1.6	20.1
A4	64.2	3.3	23.6
C4	61.1	2.7	21.4

Table 2 No. of Times (%) a Tab was Chosen with the Conventional Arrangement According to Hue and the Proposed Arrangement According to Lightness

	Patient 1		Patient 2		Patient 3	
Tab	H	L	H	L	H	L
A1	2	2	26	18	50	20
B1	6	2	24	36	38	74
B2	12	16	2	2	0	0
A2	8	6	12	0	4	0
A3	16	12	0	18	0	0
C1	20	12	28	18	6	6
B3	2	0	0	0	0	0
D2	12	32	6	6	2	0
B4	0	0	0	0	0	0
D3	6	8	2	2	0	0
D4	2	2	0	0	0	0
A3.5	0	2	0	0	0	0
C2	10	6	0	0	0	0
C3	4	0	0	0	0	0
A4	0	0	0	0	0	0
C4	0	0	0	0	0	0
Total	100	100	100	100	100	100

H = hue; L = lightness.

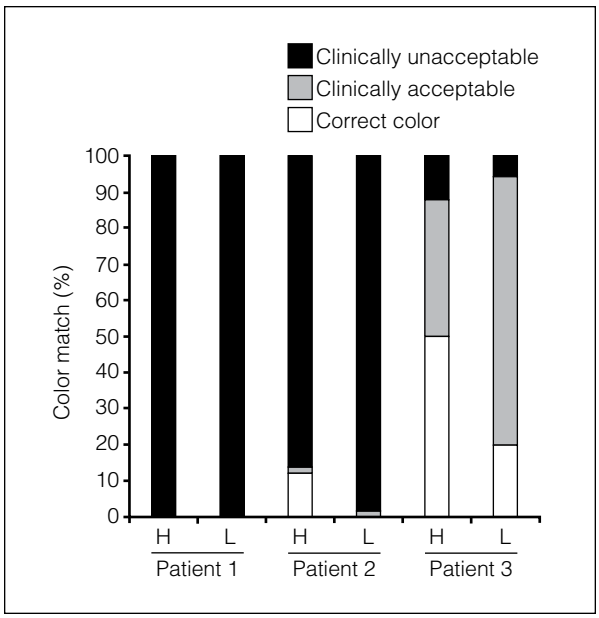

Fig 2 Color match for the three patients based on the two arrangements: hue (H) and lightness (L).

patients 1, 2, and 3, respectively. According to the equation used and the values in Table 1, the matches between the electronic and shade guide methods were evaluated in terms of correct color ($\Delta E \leq 2$), clinically acceptable ($\Delta E \leq 3.7$), and clinically unacceptable ($\Delta E > 3.7$). These results are depicted in Fig 2.

Discussion

In contrast to the hypothesis, students who used a shade guide arranged in order of lightness were not more successful in selecting the correct shade. Looking at the distribution of the visual color determinations, interestingly, the majority of students chose the lightest tab (B1) for the patient with color code A1. The shade most often chosen for the darkest tooth (C1) was D2. It seems that out of simplicity, either the darkest or lightest tabs were chosen and the tabs in between were easily overlooked.

Independent of the arrangement used, a color match could not be determined for patient 1 (C4). This implies that some tooth colors are more difficult to match than others, regardless of the arrangement of the shade guide. This is in accordance with previous investigations where the VITA color code "C" was established to be problematic to recognize.[1] The translucency level cannot be determined with the shade guide, even though evidently it has an influence on color.

Conclusions

The proposed arrangement did not result in improved shade selection when compared to the conventional arrangement based on hue groups. Translucency plays an important role in the success of shade determination, and regardless of the arrangement, there is an overall poor success rate in determining the correct shade.

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References

1. Østervemb N, Jørgensen JN, Hørsted-Bindslev P. Shade guide optimization—A novel shade arrangement principle for both ceramic and composite shade guides when identifying composite test objects. J Esthet Restor Dent 2011;23:22–32.
2. Paravina RD, Majkic G, Imai FH, Powers JM. Optimization of tooth color and shade guide design. J Prosthodont 2007;16:269–276.
3. Dozic A, Voit NF, Zwartser R, Khashayar G, Aartman I. Color coverage of a newly developed system for color determination and reproduction in dentistry. J Dent 2010;38(suppl 2):e50–e56.
4. Miller L. Organizing color in dentistry. J Am Dent Assoc 1987;spec no:26E–40E.
5. Ferreira D, Monard LA. Measurement of spectral reflectance and colorimetric properties of Vita shade guides. J Dent Assoc S Afr 1991;46:63–65.