Spectrophotometric Evaluation of Shade Selection with Digital and Visual Methods

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Aim: The main purpose of the study was to learn the possible shade differences between human eye and the digital method with spectrophotometric methods. Materials and Methods: Fifty dental students of age groups 18–25 with maxillary right central incisor after undergoing oral prophylaxis were included in this study. Before undergoing shade selection, standardization protocol was followed. The shade of the right maxillary central incisor was determined by using the following methods: visual, spectrophotometer, and digital photography. The shades obtained by both spectrophotometer and visual methods are compared and similarly \( L^* \), \( a^* \), and \( b^* \) values obtained by both spectrophotometer and digital methods are compared. Finally these comparisons are subjected to statistical analysis. Results: \( Z \) and \( P \) values of digital and spectrophotometric methods were found to be statistically significant. Tooth shade selected between spectrophotometric and visual method was analyzed by using chi-square test, which shows highly significant value. Conclusion: It was concluded that the digital photography can be used as one of the reliable methods for shade selection in a clinical setup.

Keywords: Digital photography, shade selection, spectrophotometer, visual shade matching

Introduction

A smile can change drowning things and can give positive aura.[1] But not every single person is blessed with attractive smile. The key to the above problem is esthetic dentistry which was advanced with the latest technologies for better esthetic results.[2] Inappropriate shade selection results in remake of ceramic restorations, but the main cause occurs due to improper tooth preparation and impression making.[3] Hence to overcome the problem, proper understanding and knowledge of color is important. In dentistry, prosthodontist is most likely the best person to rule out the quality of smile especially in esthetics.[4] Thus, the shade selection is considered as an important procedure in fixed prosthodontics. The main aim of the study was to analyze shade differences between the visual and digital methods using spectrophotometer.

Materials and Methods

Vita Easyshade Advance 4.0 spectrophotometer (VITA Zahnfabrik H. Rauter GmbH and Co., Bad Sackingen, Germany) and digital photography method (Canon EOS 750D, 30-2 Shimomaurko 3-chrome, Ohta-ku, Tokyo, Japan) with spectrophotometer (VITA Easyshade Compact, VITA Zahnfabrik H. Rauter GmbH and Co., Bad Sackingen, Germany).

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Germany) [Figure 1], VITA classical shade guide (VITAPAN Zahnfabrik, VITA Zahnfabrik H. Rauter GmbH and Co., Bad Sackingen, Germany) with blue reflectant card [Figure 2], and digital camera, such as Canon EOS 750D [Figure 3]. Tripod stand, 18% gray reflectant card, and Cheek Retractor, were the materials used in this study.

Fifty dental students from our dental college of age groups 18–25 with maxillary right central incisor after undergoing oral prophylaxis were included in this study. Before undergoing shade selection procedure, the teeth are dried using cotton. Discolored teeth, restorations, endodontically treated teeth, extrinsic stains, nonvital or fractured teeth, presence of crowns, and veneers are excluded and females were asked to remove the lipstick.[5] The study was proceeded after acquiring the necessary approval from the Ethical committee of the Institution and an informed consent was obtained from the students. The \( L^* \), \( a^* \), and \( b^* \) values of spectrophotometer reported along with the actual shade, whereas the image captured by digital photography method reports only the \( L^* \), \( a^* \), and \( b^* \) values using Adobe CS software (Bengel, Middle Easter Version by Adobe Version: 8.0) [Table 1].[6] The shades obtained by the visual method were marked down for further comparisons [Table 2]. The readings obtained by these different methods were compared and subjected to appropriate statistical analysis. Standardization protocol was followed during the study. All the shade matching procedures were performed by the same operator.

**RESULTS**

Tooth shade selected between spectrophotometric and visual method was analyzed by using chi-square test. Chi-square value = 62.216 and \( P = 0.0001 \) [Table 3].

| S. No. | Spectrophotometric method | Digital method | ΔE values and agreement between spectrophotometer and digital method |
|-------|---------------------------|----------------|------------------------------------------------------------------|
|       | \( L^* \) a* b*          | \( L^* \) a* b* | ΔE Agreement |
| 1     | 77.5 –2.6 9.4  | 77.9 –2.4 11 | 1.38 yes   |
| 2     | 74.3 –1.6 12.5 | 75 0.8 10  | 3.69 No    |
| 3     | 78.7 –0.2 15.3 | 78.1 –0.3 16 | 0.43 Yes   |
| 4     | 83.4 –1.4 12  | 84.1 –1.1 11.2 | 0.61 Yes   |
| 5     | 80.8 –1.6 9.4  | 80 –2.0 8   | 1.38 Yes   |

On the above basis, further 45 values are proceeded
were found to be highly significant ($P < 0.05^*$ indicates statistically significant and $P < 0.001^{**}$ indicates highly significant). On estimating value, the measurement of agreement between the spectrophotometer with digital methods and spectrophotometer with visual methods remains the same, i.e., $\kappa$ coefficient values will be 0.597 and $P$ value will be 0.001 which shows statistically significant with higher proportion. The nonparametric measure of Spearmen rank correlation is 0.628 and significant with higher proportion. The nonparametric and coefficient values will be 0.597 $\kappa$ remains the same, i.e.,, $P$ were found to be highly significant ($P < 0.05^*$).

The study. To avoid weariness or prostration of the individual observer, so a single investigator is used in the study.$^{(12,13)}$ To avoid weariness or prostration of the eye, there should be 5 s or 7 s interval for the investigator to have a look at the blue color cardboard sheet.$^{(14,15)}$ To avoid color confusion, makeup and lipstick has to be removed from the subject.$^{(16,17)}$ The subjects were viewed at the eye level by holding the shade tab next to the selected tooth.$^{(18)}$ The shade guide shows variations under fluorescence, incandescence, or daylight.$^{(19,20)}$ Hue has to be selected first followed by chroma.$^{(21)}$ Shade tab is arranged alphabetically from A to D and values from 1 to 4.$^{(22)}$ Digital photography is the third method used in this study. Recently visual method of shade selection has been replaced by the digital means.$^{(23)}$ This is because it can exactly replicate the color with its high imaging quality.$^{(24)}$ 18% gray card is used in this study for standardization.$^{(25)}$ A gray card is a middle reference point to produce constant image.$^{(24)}$ The red, blue, and green values are equal for gray card and hence it is considered as a neutral target.$^{(26)}$ As the gray card had an unquestionable value, the Adobe Photoshop CS6 also integrates as gray and thus removes the shades of particular color, which affects the photographic image partially or completely.$^{(27)}$ The image was captured as a measured distance of 70 cm between camera and patient and the proceed image was transferred to Adobe CS Photoshop to get images of the $L$, $a$, and $b$ values.$^{(24)}$ The $L$, $a$, and $b$ values are again transformed into $L^*$, $a^*$, and $b^*$ by using rule $L^* = L_1 \times 100/255$, $a^* = (a_1 - 128) \times 240/255$, and $b^* = (b_1 - 128) \times 240/255$. The difference in shade ($\Delta E$) between spectrophotometric and digital photography was intended by using the following formula: $\Delta E = [(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2]^{1/2}$. If $\Delta E$ values should be less than or equal to 2, when more than 2 it is considered that human eye is not perceptible to such values.$^{(28)}$

**DISCUSSION**

Esthetic dentistry is emerging as one of the challenging branches of this field.$^{(7)}$ Shade matching of maxillary anterior is one of the tough clinical challenges faced in dentistry.$^{(8)}$ However, spectrophotometer method of shade evaluation is considered as gold standard for dentistry.$^{(9)}$ However, spectrophotometer method of anterior is one of the tough clinical challenges faced branches of this field. Shade matching of maxillary esthetic dentistry is emerging as one of the challenging

**Table 2: Agreement between spectrophotometer and visual methods**

| S. No. | Spectrometric shade | Visual shade | Agreement |
|-------|---------------------|--------------|-----------|
| 1     | A2                  | A2           | Yes       |
| 2     | A1                  | B1           | No        |
| 3     | B1                  | B1           | Yes       |
| 4     | A2                  | B2           | No        |
| 5     | A2                  | A2           | Yes       |

On the above basis, further 45 values are proceeded.

**Table 3: Comparison between spectrophotometric method and visual method using chi-square test**

|        | Visual |       |       |       |       |       |        |
|--------|--------|-------|-------|-------|-------|-------|--------|
|        | a1     | a2    | a3    | b1    | b2    | c4    | Total  |
|        | 3      | 0     | 1     | 1     | 0     | 0     | 5      |
| a1     |        |       |       |       |       |       | 62.261 |
| a2     | 2      | 19    | 1     | 1     | 1     | 0     | 24     |
| b1     | 1      | 0     | 0     | 12    | 2     | 0     | 15     |
| b2     | 1      | 0     | 0     | 2     | 2     | 1     | 6      |
| Total  | 7      | 19    | 2     | 16    | 5     | 1     | 50     |

**$**P < 0.05**
method. When compared to spectrophotometric method, digital method of shade selection is economically low and when compared to conventional method, it records in a detailed manner to perform patient education, documentation of records, and treatments. So with certain limitations of the study, the conclusion is that both visual and digital methods of shade selection show high statistically significance of agreement with spectrophotometer.

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Conflicts of interest
There are no conflicts of interest.

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