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Pertinence of gingival shade guide systems in Indian context using visual and photographic shade estimation methods – A clinical comparative study

[1]Dr. Milen Mariam Rajeev, Director, Premiere Dental Specialties, Kanjikuzhy, Kottayam, Pin- 686004, Kerala, India.

[2]Dr. Sudeep Saratchandran, Head of the Department Professor, Department of Prosthodontics, PMS College of Dental Science &Research, Vattappara, Trivandrum, Pin- 695028, Kerala, India.

[3]Dr. Alex Mathew Muruppel, Principal & Professor, Department of Prosthodontics, Rajas dental college and hospital, Thirunelveli, Pin- 627105, Tamil Nadu, India.

[4]Dinesh Narendren, Director, SV Dental Specialty Clinic, Nedumangad, Trivandrum, Pin- 695541, Kerala, India.

[5]Sheeba Gladstone, Professor, Department of Prosthodontics, PMS College of Dental Science &Research, Vattappara, Trivandrum, Pin- 695028, Kerala, India.

[6]Dr. Joyce Thomas, Associate professor, Department of Prosthodontics, St. Gregorios Dental College, Chelad, Kothamangalam, Ernakulam, Kerala, India.

Corresponding Author: Dr. Joyce Thomas, Associate professor, Department of Prosthodontics, St. Gregorios Dental College, Chelad, Kothamangalam, Ernakulam, Kerala, India.

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Abstract

Objectives: Clinical determination and comparison of different gingival shade guide systems in Indian patients for the purpose of placement of restorations in the anterior region using visual and photographic techniques and to check the correlation of visual shade matching and the digital analysis technique.

Methodology: The screening process ensured that the potential subjects satisfied the inclusion and exclusion criteria of the study. Gingival shade guide system such as Adoro/dSIGN[R] gingival shade guide and emax[R] gingiva shade guide, were selected and studied by visual and digital method, where the patients were photographed using standardized protocols and the photographs of the shade guide were also taken in a similar environment using the similar setup, and analysed using graphics software (Adobe Photo shop). The data from the subjects were compared to that of the shade guide.

Results: The mean minimum coverage errors of emax^{R} gingival shade guide was significantly less than Adoro/dSIGN^{R} gingival shade guide. The correlation between the coverage errors of shade guides gave a Spearman's rank correlation coefficient of 0.472, (p values is 0.008) which is highly significant.

Conclusion: The study found that the agreement between the three observers were not unanimous in visual method when Adoro/dSIGN^{R} gingival shade guide was considered. Since mean minimum coverage errors of emax^{R} gingival shade guide was significantly less than Adoro/dSIGN^{R} gingival shade guide, we could conclude that emax^{R} gingival shade guide is more suitable for the Indian population.

Keywords: Shade selection, Gingival shade guide, Digital analysis, Visual shade matching, Color analysis.

Introduction

The gingiva is the fibrous mucosa surrounding the teeth covering the coronal portion of the alveolar process (Zimmerman, 1982) and is the most frequently pigmented of the intra-oral tissues as well as the most readily seen. Dummet (1966) queried the frequently used description of normal gingival as 'coral pink' and suggested a more accurate statement of the pattern of normal pigmentation in the following definition. The colour of healthy gingival varies from pale pink to bluish purple depend on the intensity of the melanogenesis, degree of epithelial cornification, depth of epithelization, the arrangement of gingival vascularity and also the fibrous nature of the underlying connective tissue pigmentation which is minimal in white people and can be found as brown or blue-black areas in Africans or Asians.

Esthetic appearance plays an essential role in patient acceptance of removable prostheses. However, in contrast to the refinement of the "white esthetics" of fixed prosthodontic work, the individual characterization of denture bases for achieving a thorough adaptation to intraoral soft tissues is rarely practiced. Currently, methyl methacrylate is the most frequently chosen acrylic resin for the fabrication of partial and complete removable denture bases[1]which can be tinted by coating with light-curing resins like Dentacolor System (Heraeus Kulzer). Denture bases made with the Ivo cap system (Ivoclar Viva dent) can be individualized with the "Denture Stain Kit Ena Resin," a heat polymerizing acrylic resin that contains several colouring agents. Color assessment of human gingival and mucosal tissues is an essential first step in the development of an intraoral soft tissue shade guide. Such measurements can be performed using visual, spectrophotometric, or photographic techniques. Knowledge of the distribution of gingival and mucosal shades is almost equally important for the individual configuration of denture base color.

The results of an investigation on evaluating the reliability on shade guides revealed that software programs can be used effectively to analyse the colour of digital images[2]and also the color measurements obtained with digital analysis method are found to be in accordance with those of spectrometric evaluations, with respect to CIE L*a*b*values a* and b*.Reliability on Digital Cameras for colour selection showed that a 5 megapixel camera[3] showed agreement of over 60% with the spectrometric analysis and that an upgrade by 8.2 megapixels resolution will give us 100% success rate.[4] This investigative approach explores the mean minimum Coverage Errors (CEs) of 3 different commercially available gingival shade guides in an Indian population to find the agreement between the performance of the observer and the digital analysis.

Methodology

The study was conducted in the Patients attending the OPD of Department of Prosthodontics, PMS College of Dental Science and Research, Trivandrum were selected after screening. Partially edentulous healthy subjects having Kennedy's Class III or Class IV situation with one or more teeth missing in the anterior region between the ages 17 – 30 years and willing to spend approximately an hour in the study after signing the informed consent were included in the study.

Whereas patients with psychiatric, cognitive or social conditions (e.g., alcoholism or drug abuse), mucosal lesions or spontaneous gingival bleeding due to periodontal disease and pregnant subjects were excluded from the study. The sample size was fixed as 30 based on the factors such as time availability, study subject availability & necessary degree of precision. Gingival shade guide system such as Adoro/dSIGN^{R} gingival shade guide and emax^{R} gingiva shade guide, were selected and studied. (Figure 1&2)

Fig 1&2: Shade guide 1 & 2 (Adoro/dSIGN^{R}gingival shade guide)

Figure 1

Figure 2

For Visual Shade Matching

The shade of the attached gingiva was analysed visually by 3 operators separately to account for operator variability. The observers were primarily screened for refractive errors and were subjected to the 'Ishihara test' to eliminate color blindness and were found to be free of any visual inadequacies. Shade selectionwas done between 1100 hrs to 1400 hrs in daylight on a clear day (Fig. 3). The Visual Shade matches thus collected is manually entered in a tabulated Performa. (Table 1)

Fig 3: Visual shade matching

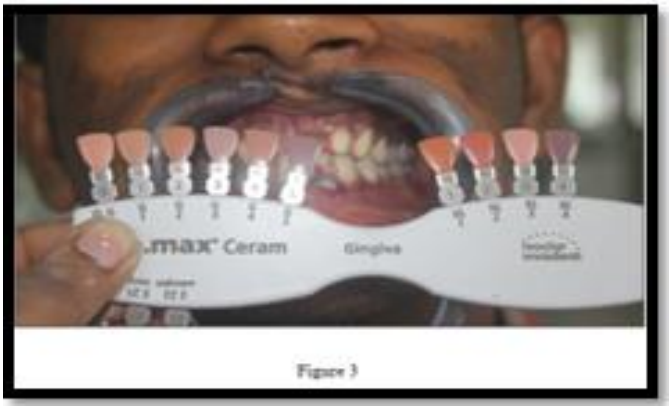


Figure 3

For digital analysis

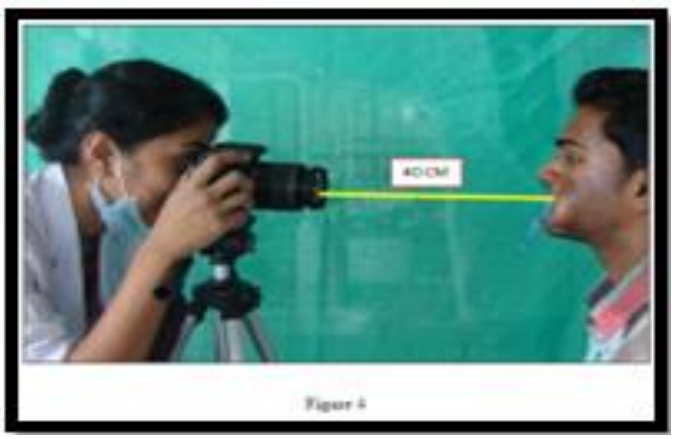
A digital camera was fixed on a tripod at a distance of 40 cm from the subject. The camera oriented perpendicular to the shade guides to obtain the digital image. The photographs of the shade guide were also taken in a similar environment using a similar setup (Fig. 4). The image was taken at about 1100hrs, under daylight, on a clear day; and was saved in JPEG format.

Table 1: Shades of the three observers by visual method

Samples	**Shade guide 1 & 2**			**Shade guide 3**		
	Observer 1	**Observer 2**	**Observer 3**	**Observer 1**	**Observer 2**	**Observer 3**
	G4	G4	G2	G4	G4	G4
	IG4	IG4	IG4	E22	E22	E22
	IG4	IG4	IG4	E22	E22	E22
	G4	G4	G4	G4	G4	G4

	IG4	IG4	IG4	E22	E22	E22
	G5	IG4	G5	E22	IG4	E22
	G4	G4	G4	G4	G4	G4
	G4	IG3	G4	G4	IG3	G4
	IG4	IG4	IG4	E22	IG4	E22
	IG4	IG4	IG4	E22	E22	E22
	IG4	G5	IG4	E22	IG4	IG4
	G4	G4	G4	G4	G4	G4
	IG4	IG4	IG4	E22	E22	E22
	G4	G4	G4	G4	G4	G4
	IG4	IG4	IG4	E22	E22	E22
	G4	G4	G4	G4	G4	G4
	IG4	IG4	G5	G5	E22	E22
	IG4	IG4	IG4	E22	E22	E22
	IG4	IG4	IG4	E22	E22	E22
	G3	G5	G5	E22	IG4	E22
	IG4	IG4	G5	E22	E22	IG4
	IG4	IG4	G5	E22	E22	E22
	IG4	IG4	G5	E22	E22	E22
	IG4	IG4	IG4	E22	E22	E22
	G4	G4	G4	G4	G4	G4
	IG4	IG4	IG4	E22	E22	E22
	IG4	IG4	G5	E22	IG4	IG4
	IG4	IG4	IG4	E22	E22	E22
	IG4	IG4	G5	E22	E22	IG4
	IG4	G5	IG4	E22	G5	IG4

Figure 4: Digital photographs taken



The images were resolved on a 32-bit resolution screen, and were analysed using graphics software (Adobe Photoshop®). During the analysis, fixed circular areas, i.e., in the attached gingiva portion were selected. The R, G, B values were calculated using the Adobe Photoshop® Software (Fig 5). Further these values were mathematically interpreted to the CIE Colour System values of L*, a* and b* values using a colour calculatorat digital colour atlas® 3.0.

Figure 5: Color analysis using adobe Photoshop

Colour Analysis

The data from the subjects is compared to that of the shade guide. i.e., data of each subject was calculated in relation to each shade of the shade guide. The difference in shade will be calculated using the following equation:

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

ΔE is the difference in color, L^*_g a^*_g b^*_g indicates the colour coordinates derived from the gingival surface of the patients. L^*_s a^*_s b^*_s indicates the colour coordinates derived from each shade tab. The shade tab that shows least ΔE value was considered to be the closest match to the shade of the gingiva, which was then similarly done for the other gingival shade systems. (Table 2).

Table 2: Least ΔE values of 30 samples

Samples	Shade guide 1&2	Δe	Shade guide 3	Δe
1	IG4	39.3125	E22	0.0427246
2	G5	8.46875	E22	0.0661621
3	IG4	107.875	E22	0.1573486
4	IG4	23.375	E22	0.0328369
5	IG4	26.8125	E22	0.0517578
6	IG4	16.625	E22	0.0062256
7	IG4	24.3125	E22	0.0231934
8	IG4	23.25	E22	0.0108643
9	G3	9	E22	0.0339355
10	IG4	13.3125	E22	0.017334
11	IG4	21.0625	E22	0.0241699
12	IG4	4.875	E22	0.0111084
13	IG4	56.8125	E22	0.0961914
14	IG4	16.25	E22	0.0435791
15	G0P	56.5	E22	0.1583252
16	IG4	287.3125	E22	0.604248
17	IG4	25.0625	E22	0.048584
18	G5	5	E22	0.0528564
19	IG4	9.6875	E22	0.0192871
20	G3	24.5	E22	0.0450439

21	IG4	23.0625	E22	0.0305176
22	IG4	15.6875	E22	0.010498
23	IG4	27.875	E22	0.0501709
24	IG4	33.375	E22	0.0240479
25	IG4	23.625	E22	0.0159912
26	IG4	21.375	E22	0.0279541
27	G5	25	E22	0.0279541
28	G5	5	E22	0.0528564
29	IG4	9.6875	E22	0.0192871
30	G5	41	E22	0.0938721

Coverage Error (CE)

After computing the least ΔE value, the coverage error was calculated. For each of 30 patient's gingivae, the shade tab with the smallest ΔE is determined for the shade guide system. The average minimum ΔE for that shade guide system was then calculated. The coverage error is therefore the average ΔE between each of the 30 patient's gingiva and the corresponding shade tab with the minimum ΔE to that gingiva. The following formula was used to calculate the average ΔE which is the index of CE of the shade guide system:

$$CE = \frac{\sum \Delta E_{min}}{n} = \frac{\sum \text{Min} \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}}{n}$$

Where ΔL^*, Δa^*, Δb^* are difference in colour parameters between the patient's gingiva and the closest shade tab selected by the computer algorithm.

Results

The methodology followed by this study derived the following results

The study found that in Adoro/dSIGN^R gingival shade guide there is no unanimity in agreement between the observers which is as follows

Shade Guide 1 & 2

- Observer1 vs Observer 2 – 83.3%
- Observer 1 vs Observer 3 – 73.3%
- Observer 2 vs Observer 3 – 63.3%

In contrast, emax^R gingival shade guide gave more unanimous agreements between the observers.

Shade Guide 3

- Observer1 vs Observer 2 – 73.3%
- Observer 1 vs Observer 3 – 80%
- Observer 2 vs Observer 3- 76.6%

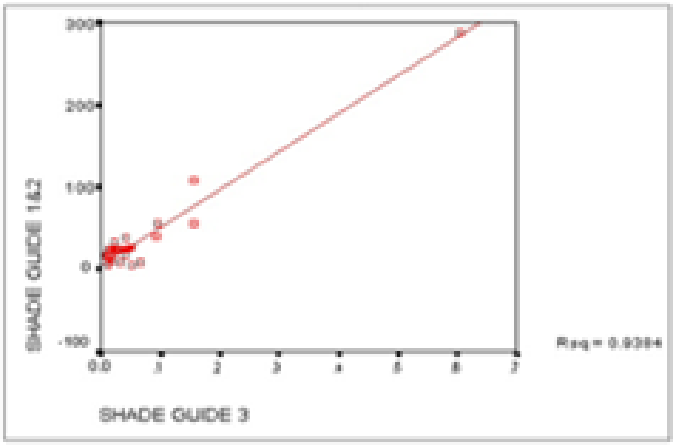
The study revealed that there was inconsistency in reliability of visual shade matches when compared to the digitally analyzed shades with only 46.67% of agreement for shade guide I & II and agreement of 77% for the shade guide III.

1. These findings were found to be consistent with various previous studies of Elter[5] and Hugo[6] that state there is a significant disagreement between the shades selected by human perception and the shade obtained with computer-aided instrumentation.

2. The mean minimum coverage errors of emax^R gingival shade guide was significantly less than Adoro/dSIGN^R gingival shade guide. The correlation between the coverage errors of shade guides I, II & shade guide III gave a spearman's rank correlation coefficient of 0.472, (p values is 0.008) which is highly significant. Shade guides I &II gave a mean value of

correlation of 34.1698 and standard deviation of 51.97 whereas for shade guide III, the mean is 0.0633 with standard deviation of 0.1089. Since the standard deviations of coverage errors of both the shade guides are 1.5 times more than the mean value, spearman's rank correlation was applied as the appropriate measure of correlation. (Graph 1)

Graph 1: Scattered diagram showing the relationship between the coverage error of shade guide I. II & III Scattered diagram showing the relationship between the coverage error of shade guide I. II & III



Graph -1

Discussion

Color assessment of human gingival and mucosal tissues is an essential first step to developing an intraoral soft tissue shade guide. Knowledge of the distribution of gingival and mucosal shades is important to achieve individual customization of denture base/ceramic color, when the right shade is identified it gives a natural look to the prosthesis. The accuracy, versatility and suitability of the gingival shade guide for each particular population as compared to a tooth shade guide varies according to the ethnic population.

Dummet (1946) reported gingival pigmentation to be 60% in blacks in his study of the distribution of oral pigmentation that the color of the attached gingiva is generally light coral pink in with an orange peel like texture, while the alveolar mucosa is a darker red-blue color which is smooth and shiny in nature (Zimmerman, 1982). It may be noted that a definite correlation exits between the colour tone within the oral cavity and the external pigmentation of the individuals in White, Negroes, Asiatic and Indian populations. The use of a helium-neon gas laser to record the reflectance of the interdental papilla was documented, although no actual color was reported. Another study used digital images of gingiva and converted the color of gingiva into its corresponding wavelength, but without any documentation of validity or reliability[7].

emax^{R} gingival shade guide gave more unanimous agreements between the observers than Adoro/dSIGN^{R}gingival shade guides. But the study revealed that there was inconsistency in the reliability of visual shade matches when compared to the digitally analyzed shades with only 46.67% of agreement for shade guide I & II and agreement of 77% for the shade guide III.

Elater et al in their study to check the reliability of digital cameras for colour selection compared colours determined using a spectrophotometer, digital cameras and visual shade matching, the values obtained using visual shade matching only reached 26.6% and 46.6% in agreement with the spectrophotometric values, and also recommended that to achieve a 100% color match using digital analysis an overall camera resolution of 13.2 megapixels is indicated[8].

This study conducted on a limited regional sample of the population and it measured only the attached gingiva and not from several sites from the same structure, such as interdental papilla, marginal, and non-attached gingival to determine which site(s) most accurately represents the correct shade. More research is needed to evaluate the available gingival shade guide systems and its

applicability in a global perspective especially the Asiapasefic and the African ethnic origins where wide range of darker pigmentations make it difficult to match the shade in the existing systems. Which direct us towards the need for development of a more elaborated shade guide systems which fulfil the gingival shade matching of regional populations by adding more shade tabs thereby increasing the range of shade selection.

Conclusion

Nevertheless, within the limitations of this study, the investigations has validated earlier work by Elater et al who also found that there is significant disagreement between shade selected by human perception & computer aided shade selection. We could successfully derive the following **conclusions**

- The study found that the agreement between the three observers is not unanimous in visual method when Adoro/dSIGN^{R}gingival shade guide was considered. Whereas in emax^{R} gingival shade the agreement was more unanimous in visual method.
- The study revealed that there was inconsistency in reliability of visual shade matches when compared to the digitally analyzed shades with only 46.67% of agreement for shade guide I & II and agreement of 77% for the shade guide III.
- Since mean minimum coverage errors of emax^{R} gingival shade guide was significantly less than Adoro/dSIGN^{R} gingival shade guide, we could conclude that emax^{R} gingival shade guide is more suitable for the Indian population. But further research has to be conducted with more sample size and using other shade guide systems.

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