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Original Research Article

In pursuit of gold standard shade guide method, a comparative in-vivo study between manual and digital shade guides

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ABSTRACT

Introduction: The available shade guide system in dentistry includes Manual and Digital. Although there is lot of research going on better system to choose dental shade but still there are many factors including source of light illuminating the tooth, the characteristics of tooth and the observer viewing the tooth which needs to study further. In this study, a comparative analysis is made between the Manual and Digital shade guide systems.

Objective: The objective of the study is to record the manual (subjective method) and a digital shade (Objective method) of 500 subjects by two observers (Prosthodontist 1 {P1} and Prosthodontist 2 {P2}).

Materials and Methods: 500 patients having a complete set of anterior teeth with sound maxillary central incisors were selected for the study. Manual shade selection (Vita 3D Master) of 50% of subjects is made by P1. Then P2 does shade selection of the same subjects by digital method (Vita Easy Shade Advance) and records the deviation of values including ΔE, ΔL, ΔC, and Δh by digital shade guide from the manual shade as recorded by P1 using verification mode of Digital shade guide. Recording of shades and deviation values is done for the remaining 50 % of patients by role reversal between P1 and P2.

Results: The kappa correlation values for Hue value and chroma when P1 records manually and P2 documents shade by digital shade guide include 0.26, 0.42, and 0.13 indicating fair, moderate, and slight to no agreement respectively. The kappa correlation values for Hue value and chroma when P2 records manually and P1 records shade by digital shade guide include -0.08, 0.51 and 0.12 indicating no agreement, moderate and slight to no agreement respectively.

Conclusion: It is advisable to use technology to overcome the errors of subjectivity. Due to edge loss with a spectrophotometer, especially in the incisal and cervical region, a combination of digital and manual systems always comes in handy when deciding on a particular shade or shade map.

1. Introduction

On stimulating retina of eye by particular wave length of light, results into colour sensation as transcribed by the brain.[1] Traditionally shade selection of tooth is done by visual shade matching.But it has many drawbacks like it is subjective, it's non uniformity, incapability to include complete range of natural tooth shade,it's dependency on light source and variation due to surface texture.To overcome these limitations, colorimeters and spectrophotometers which are clinically applicable and probably more reliable instrument have been used. This

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technology-based colour matching is an objective method that provides quantified and reproducible data.[1,2] But again pitfalls with these digital shade guides are they are expensive and only base shade can be determined reliably.

For traditional method of visually matching shades, 5500 K light temperature and the colour rendering index more than 90 are recommended. Lower or higher temperatures of light source produce difference in colour distributions of shade guide for the teeth being matched which invariably reduces observer's ability to match shades.However the success of colour matching is evaluated visually by how closely the final prosthesis resembles the natural tooth to a casual observer.

Munsell colour system is mainly based on visual colour matching. It has not included the spectral properties, which limit its scope in research. A downside of CIELAB is that colour differences cannot be described in terms of a change of hue and chroma which makes it less applicable in the clinical practise. L*c*h* descriptors allows colours in the CIELAB colour space to be deciphered in terms of lightness, chromaticity and hue. These variables are more clinically appropriate and relevant. Digital shade guides which are available today are ingrained with most common shade tabs like classic or 3D master so that clinical correlation can be achieved.

In this study, we are giving an insight whether both the metholodology can be used in our setup or have to do further research to know the best methodology to be followed in future by doing spectrophotometric evaluation using Vita 3 D master (Figure 1) and Vita Easy shade Advance 4.0 (Figure 2) which cover the complete range of natural tooth shades. ΔE values using spectrophotometric and visual methods are determined and analysed if they fall in the acceptable range.

Fig. 1: Vita 3 Dmaster

Fig. 2: Digital spectrophotometer

2. Objectives

The research objectives are to record the manual (subjective method) and a digital shade (Objective method) of 500 subjects by two observers (Prosthodontist 1 {P1} and Prosthodontist 2 {P2}).

3. Material and Methods

The current in vivo study was conducted using manual shade guide as provided in VITA 3D- MASTER and digital shade guide as provided in VITA Easyshade Advance.

3.1. Sampling

A total of 500 patients including both genders from 20 to 45 yrs. were selected from the OPD from Government Dental centre of Leh.

3.2. Inclusion criteria

1. Subjects (male or female) willing to participate in the study within the age group of 20-45 years.
2. Subjects having all the anterior teeth with flawless upper central incisors.

3.3. Exclusion criteria

1. Any Discoloration of anterior tooth/teeth
2. Caries, restorations, Non vitality in the anterior teeth
3. Subjects having smoking habit
4. Subjects with poor oral hygiene
5. Presence of any enamel or dentinal defects
6. Fractured central incisors
7. Small dimension central incisor

3.4. Methodology

The values determined in this study included:

ΔE - The overall color deviation of the tooth

ΔL +/-: The tooth's lightness is higher (+)/ lower (-) than the VITA 3D Master

ΔC +/-: The tooth's chroma is higher (+)/ lower (-) than the VITA 3D Master

Δh +/- :The tooth's hue is yellower (+) / redder (-) than the VITA 3D Master

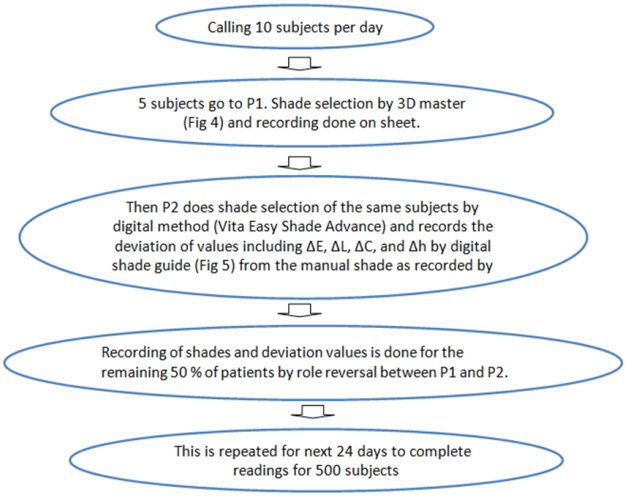

Fig. 3: Sequence of events for conducting comparative analysis between Manual and Digital shade guides

4. Results

The kappa correlation values for Hue value and chroma when P1 records manually and P2 documents shade by digital shade guide Include 0.26, 0.42 and 0.13 indicating fair, moderate, and slight to no agreement respectively. The kappa correlation values for Hue value and chroma when P2 records manually and P1 records shade by digital shade guide include -0.08, 0.51 and 0.12 indicating no agreement, moderate and slight to no agreement respectively. The Mean values of above data is given in Table 1.

Table 1: The mean for Kappa Co-relation of Hue , Value and Chroma

	Hue	Value	Chroma
First scenario			
Mean Value	0.26	0.42	0.13
Remarks	Fair agreement	Moderate agreement	Slight or No agreement
Second scenario			
Mean Value	-0.08	0.51	0.12
Remarks	No agreement	Moderate agreement	Slight or No agreement

Fig. 4: Shade Matching by Manual shade guide

Fig. 5: Shade matching by digital Spectrophotometer

5. Discussion

Reproducing an accurate shade is difficult as it is subjective and challenging because colour is not easily quantifiable. On the other hand standard colour specimens are flat, opaque and of an isolated colour while human teeth have non-planar surfaces and non-homogenous in their structure, colour and translucency.[3]

The colour sensation composed of three parts and it depends on the illuminating light source, the spectral reflectance characteristics of the object and the kind of human colour perception.[4]

5.1. Perceptibility and acceptability

Colour differentiation based on the physiological sensitivity of the human visual system is called Perceptibility. When

measuring perceptibility, an observer is not interpreting the importance of the difference but assessing only if a difference exists. In other words, the human observer functions like a colour difference detector. On the other hand, acceptability of a colour change is a discernment of the colour difference in relation to the actual situation.[5,6]

Dental restoration need not to have the exact colour measurements as the patient's natural teeth. A successful dental shade match has both a threshold for perceiving differences in colour and a threshold for aesthetic acceptability.[5,7]

Douglas RD, Steinhauer TJ, Wee AG fabricated 10 maxillary test dentures of varying shade mismatch between left and right central incisors to study threshold of colour perception and clinical acceptability. They reported less tolerance for perceptibility compared to acceptability.[8]

Douglas, R. D., and J. D. Brewer in 1998 studied metal ceramic crowns for acceptability of shade difference and found its mostly depends on chromaticity.[9]

Tooth colour values obtained from a colorimeter and a spectrophotometer differed greatly using the same study population.In addition, colorimeters and spectrophotometers with small port openings are prone to edge loss effects, resulting in less accurate results due to systematic error. Edge loss occurs when light is scattered laterally through the translucent portions of teeth (especially at the incisal thirds of anterior teeth) out of the measuring area of the instrument.[10]

Bayindir et al investigated the coverage error of VITA Classical and VITA 3D Master in a sample population of 120 subjects, ages 18 to 85 years old. Five sets of shade guides from each system and the central incisors, lateral incisors and canines of the subjects were measured with a spectroradiometer (PR 705, Photo Research Inc, Chatsworth, California) using 45 degree illumination and 0 degree observation. The research group found that the coverage error of VITA 3D Master (3.93 ΔE units) was significantly lower than that of VITA Classical (5.39 ΔE units).[11]

About 8% of males and about 2% of females have genetically determined defective colour vision. These people have reduced ability to discriminate red-green or blue-yellow aspects of colours because their retinas do not have one or more cone types.[12]

Compared to manual method of shade selection electronic devices are more objective. Various studies indicates shade matching may be improved by using an electronic device.[13–16] The spectrophotometer success depends on its correct use with respect to situations like surface coverage by probe tip i.e, spot or entire tooth surface, correct positioning, centering and angulation as well as the execution capability of the device software. These digital devices do have following limitations

1. The phenomenon of edge loss affects the accuracy of colour measurement.
2. Translucent mapping is inadequate for all systems.
3. Placement of the probe or mouthpiece seems to be important for the repeatability of the measurement.
4. Relatively expensive.

6. Conclusion

In the current study, spectrophotometer was used to record the base shade which is the dentinal centre of the tooth. Edge loss was almost avoided by using the flat surface of the tooth for shade selection and avoiding incisal region which are translucent and cervical region which are not flat. Thus they provided the standard shade every single time. The manual shade guide though was not far behind. The mean ΔE was much below 5.5 which is the acceptable colour difference for any restoration.

To conclude, whenever possible technology has to be used to overcome errors of subjectivity due to operator capability, lighting variation and background variation. Due to phenomenon of edge loss with spectrophotometers especially in incisal and cervical region, a combination of both the digital and manual systems always comes handy in deciding a particular shade or shade map.

7. Conflict of Interest

There are no conflicts of interest in this article.

8. Source of Funding

None.

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