Research Article

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Assessment and Comparison of Reliability of Conventional Visual Shade and Spectrophotometer Shade Matching Systems In Fixed Prosthetic Rehabilitations

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ABSTRACT

Aim: To compare and access the reliability of visual shade matching and spectrophotometer shade matching systems.

Material and methods: A total of 10 dental students from final year, who volunteered to participate in the study. For shade matching labial surface of maxillary central incisor (middle third) was assessed for 5 test subjects. The visual shade selection method was done using the commercially available shade guide VITAPAN 3D Master and for the instrumental shade selection method, the spectrophotometric shade matching was done using an intraoral spectrophotometer VITA Easyshade. Differences in colour (ΔE) and value (ΔL) between the natural teeth and the shade determined for each method. Statistical evaluation was done using statistical software SPSS version 21 (IBM Inc., Armonk, NY, USA and Chi square test.

Results: Overall, the spectrophotometric method was found to be more accurate in colour selection than the conventional visual method. The light difference (ΔL) for both the methods was not statistically significant.

Conclusion: Thus, as per the variables of our study that the spectrophotometric method of shade selection definitely proves to be a better option than the conventional visual shade guide method.

Keywords: Reliability, shade guide, spectrophotometer, visual shade guide.

INTRODUCTION

With the increase in aesthetic awareness among patients, the demand of modern ceramic and composite restoration materials has also increased. Thus perfect colour match of these tooth coloured restorative materials with that of the colour of natural dentition is the biggest key to success for such restorations.[1] Its been reported by various authors that about 80% of the patients remain unsatisfied with the discrepancy in colour matching between their restoration and the adjacent teeth.[2,3]

Thus the most important and critical steps related to the aesthetics of any tooth coloured restoration depends on its designing, precision in shade selection, its translucency and ability of dentist to replicate it.[4] Shade matching for a restoration is said to be an art and a science, which requires both the skill and knowledge regarding the colour system and methodologies of shade selection. For the purpose of shade selection commonly used methods

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include both visual and instrumental methods, out of which

Visual shade selection method being the more popular one. Visual shade section with the help of commercially available shade guides is the most commonly used method, in which the selection is done by comparison of a patient's tooth with a colour standard from the shade guide. But this method has its certain drawbacks as is easily affected by variables such as external light conditions, mesmerism, light reflection, eye fatigue, color blindness and individual characterization of natural teeth.[5-6] Not only this even some authors have reported that the available shade guide systems do not represent the full spectrum of colour found in natural teeth which adds on to the limitations of this method.[7,8] Instrumental methods for shade selection includes use of colorimeters or spectrophotometers and are reported to be better alternatives to the visual methods as the results from this method can be easily obtained and quantified. But apart from its advantages, this method also has some limitations. This method has been primarily used in the research field and its use in clinical practice is limited.

Many researchers have conducted studies to compare the results of visual and instrumental methods of shade selection but the results obtained are still non-conclusive. Therefore the aim of our study was to compare and access the reliability of visual shade matching and an intra-oral spectrophotometer shade matching.

MATERIAL AND METHODS

The present study included a total of 10 dental students from final year form 98 students, who volunteered to participate in the study and using sample size calculation formula;

$$ss = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where: Z = Z value (e.g. 1.96 for 95% confidence level)
p = percentage picking a choice, expressed as decimal (.5 used for sample size needed)
c = confidence interval, expressed as decimal (e.g., .04 = ±4)

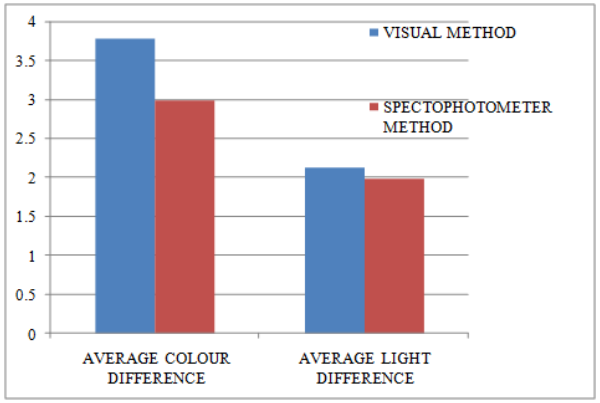
An informed consent was taken from the students participating in the study. Standard Ishihara test was performed for each student and only those who had no colour vision deficiency were included in the study. All the students were explained the proper technique of shade matching (both visual and instrumental) and the explained various factors affecting shade matching procedures through a power point presentation. It was ensured that the students had a complete understanding of the technique and principles of shade matching.

For shade matching labial surface of maxillary central incisor (middle third) was assessed for 5 test subjects. These test subjects were also volunteer dental students who had no knowledge regarding shade section. For the visual shade selection method, the commercially available shade guide VITAPAN 3D Master™ (Vita Zahnfabrik, Bad Sackingen, Germany) was used in this study. The colour matching was done under standardized lighting conditions. Each student was asked to choose the best match for middle third of maxillary central incisor. An A4 sheet of gray card was used to avoid fatigue to subject's eyes in between shade assessments. Similarly for the instrumental shade selection method, the spectrophotometric shade matching was done using an intraoral spectrophotometer VITA Easyshade™ (Vita Zahnfabrik, Bad Sackingen, Germany Fig-1) headpiece attached with outside system assembly. The spectrophotometer was used in the "shade tab" mode. Again each student was asked to choose the best match for middle third of maxillary central incisor. The assessments of the results were done according to the procedure documented by Alshiddi et al[9]. According to the procedure followed all the eight complete sets of Vitapan 3D-Master shade guide were used for the visual method. Whereas only two sets were selected randomly from the total eight sets, and each shade tab of these two sets was subjected to a standardized spectrophotometric measuring process using a positioning guide. Once the readings were recorded for spectrophotometer, CIE L*a*b* colour parameters were determined for each two shade tabs with the same number and the Δ E was calculated using equation: $\Delta E = [(L2-L1)^2+(a2-a1)^2+(b2-b1)2]^{1/2}$. Thus using the average CIE L*a*b* score a colour library was formed as a reference to compare the two methods used for shade selection.

In the visual method using VITAPAN 3D Master, the shade number selected by each subject was converted to CIE L*a*b* colour parameter system using the created colour library. The difference in observations between the two methods was calculated using $\Delta EVS=[(L_{SP}-L_{VS})^2+(a_{SP}-a_{VS})^2+(b_{SP}-_{VS})^2]$. Similarly for the instrumental shade method, the shade number was recorded for each observer and then converted to CIE L*a*b* colour parameter using the created colour library. The shade measured was assessed by calculating the difference between the CIE L*a*b* colour parameter of the shade number and the CIE L*a*b* colour parameter measured by the Spectro Shade for the same test person using equation $\Delta E_{ES}=[(L_{SP}-L_{ES})2+(a_{SP}-a_{ES})2+(b_{SP}-b_{ES})2]^{1/2}$

Table 1: Showing total number of observations using both visual and spectrophotometer method.

METHOD USED FOR SHADE SELECTION	NUMBER OF OBSERVATIONS	TOTAL OBSERVATIONS RECORDED
VISUAL METHOD	50	100
SPECTOPHOTOMETER METHOD	50	



Graph 1: comparison of average colour difference (δe &δl) betwen both visual and spectophotometer methods in the study.

RESULTS

All the values and observations were tabulated and sent for statistical evaluation using statistical software SPSS software version 21 (IBM Inc., Armonk, NY, USA). The differences between examiners and shade guide systems were assessed using Chi-Square tests. With a total of 10 trained observers and 5 test subjects, a total of 100 observations were recorded which included 50 from the visual method and 50 from the spectrophotometer as shown in Table 1. When the results of colour difference (ΔE) were observed among all the observers, an average score of 3.78 was calculated for the visual method of shade selection where as an average score of 2.98 was calculated for the spectrophotometer method. The difference in the values of both the methods was found to be statistically significant. Similarly, when the results of light difference (ΔL) were observed, an average score of 2.12 was calculated for the visual method of shade selection where as an average score of 1.98 was calculated for the spectrophotometer method. Though the visual method had a higher score but the difference was not found to be statistically significant (Graph 1).

Fig 1: Spectrophotometric System.

DISCUSSION

As we know that the most important and critical step related to the aesthetics of any tooth coloured restoration depends on its designing, precision in shade selection, translucency and ability of dentist to replicate it. Thus it becomes challenging for the dentist to restore the dentition of the patient with a perfect shade match. Visual shade section method with the help of commercially available shade guides is the most commonly used method by the practitioners but it has its own limitations because of being subjective and easily affected by many variables. Authors like van der Burgt et al[10], Witkowski *et al*[11] and Sproull *et al*[12] reported the drawbacks of this method which includes firstly the colours of these commercially available shade guides are inadequate and not well distributed. Secondly lack of consistency among the clinicians

using this shade guide and inability to translate the results of the shade guides. Despite these limitations, the human eye is very efficient in detecting small differences in colour between two objects with differences as small as 1.0ΔE units, detectable under standardized conditions and larger differences (of the order of 3.7ΔE units) detectable intraorally.[4] Commercially many visual shade guide systems are used but for our study we used the Vitapan 3D-Master shade guide system, because it gives superior shade matching results, and is designed with more standardized colour differences (ΔE=5) between adjacent shade tabs.[13-15]

Alternative to above used method another method of shade selection used is the spectrophotometer method. The shade matching instruments like colorimeters, spectrophotometers were introduced in the late 1990s and are reported to be better alternatives to the visual methods as the results from this method can be easily obtained and quantified. These devices consists of a detector and signal conditioner and software that processes the signal to make the data usable in the clinic or laboratory.[16] But apart from its advantages, these devices also has some limitations like being expensive and requires proper technique and handling. In the present study we compared the accuracies of visual (VITAPAN 3D Master™) and spectrophotometric (VITA Easyshade™) (Fig-2) shade matching systems. A total 100 observations were recorded which included 50 observations from the visual method and 50 from the spectrophotometer method. The results of our study showed that overall spectrophotometric methods (VITA Easyshade™) were found to be more accurate for shade matching than the visual method. The results of colour difference (ΔE) for the visual method gave an average score of 3.78 as compared to the spectrophotometer method which gave an average score of 2.98. The difference in the values of both the methods was also found to be statistically significant ($p<0.05$). The smaller the Δ E value, more accurate is the tooth shade matching. The results of this study are in accordance with other authors like Cal E *et al* and Johnston *et al* who also reported that the spectrophotometer method produced accurate results as compared to the traditional visual method.[16-18]

In contrary Hugo et al. reported that visual method showed a significantly higher agreement value when compared with computer-aided tooth shade determination device. They reported agreements of between 27.8% and 37.1% for instrumental methods compared to 52.9% for the human eye.[19] In another study done by Parameswaran V et al, significant differences were found between both the methods, with the visual method producing more accurate results than the spectrophotometric method. The spectrophotometric method produced a greater level of interpreter agreement when compared to the conventional visual method.[6] Similarly Ratzmann *et al*. also showed that validity was better for visual than for electronic color assessment methods.[20] When the results of light difference (ΔL) were observed, an average score of 2.12 was calculated for the visual method of shade selection where as an average score of 1.98 was calculated for the spectrophotometer method. The difference was not found to be statistically significant. Alshiddi *et al*[9] also reported similar results in their study. They included both trained and untrained observers in their study and thus suggested that training in shade matching can improve the ability and sensitivity of human eye to differentiate the value (brightness) of natural teeth. Chen *et al* [21] also inferred that the inter-examiner agreement of the spectrophotometer is good even though doubts still remain regarding the accuracy of the shade match.

In contrast to our results Lehmann *et al* found spectrometry matching as superior to visual one and they also concluded that it can be influence by gender. [22] Where as Moodley *et al* suggested to use both visual and spectrometry method in color matching for accuracy. [23]

The results of the present study suggest instrumental shade selection methods better than the conventional visual shade guides. The reproducibility and colour matching both proved to be better than the conventional visual methods. But certain limitations are definitely associated with the study design of our study as well. Firstly a larger sample size could have been in this study. Also as we used one visual shade guide available in the market, few other commonly used by the clinicians could also have been incorporated for comparisons

in this study. Further long term studies on larger sample sizes are required.

CONCLUSION

For accurate and precise colour matching and shade selection better instrumental methods should be used by the clinicians so that variables like accurate colour, translucency and surface texture which blends with the adjacent natural dentition could be achieved by the dentist and ultimately best asthetics can be delivered to the patient. Thus we can conclude from our study that the instrumental method of shade selection definitely proves to be a better option than the conventional visual shade guide method. Such advancements should be adopted by the in their clinical practice for best results and better patient satisfaction.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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