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Original Article

A clinical study to evaluate the reliability of light-correcting devices in clinical shade selection

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ABSTRACT

Background: Visual and advanced instrumental methods are the most common tools for shade selection. The instrumental methods are considered reliable and provide quantifiable values, but the high cost puts them out of the reach of most dentists. Light-correcting devices provide an economical alternative for clinical shade selection. The aim of this study was to assess the reliability of the light-correcting device in clinical shade selection.

Materials and Methods: The *in vivo* experimental prospective study sample included 60 volunteers aged 18–25 years, with no severe enamel pigmentation or anomaly in anterior maxillary teeth. Two observers performed visual shade matching of the maxillary right central incisor without a light-correcting device and later with a light-correcting device at the same time of the day at an interval of 1 week. The shades were confirmed with the control value obtained by using a spectrophotometer. Each observer was blinded to the shade color selected by the other examiner. The data collected were subjected to the statistical analysis. The shade measured with the light-correcting device and without its use was compared with the control shade obtained by the spectrophotometer. The value closer to the control shade value was considered accurate, and the method used for shade matching would be considered reliable. The Fleiss kappa statistical test was used to assess the reliability of each method. $P \leq 0.05$ was considered statistically significant.

Results: Using a light-correcting device significantly increased the reliability of the visual shade selection method. When compared to the shades recorded by the spectrophotometer (control), the use of a light-correcting device as an aid in visual shade selection showed more accurate and reliable results as compared to the visual shade selection without a light-correcting device ($P < 0.05$).

Conclusion: Light-correcting devices can assist in reliable shade selection and allow better communication with the dental laboratory technician to provide predictable esthetic results.

Key Words: Color, dental enamel, esthetic

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INTRODUCTION

Accurate shade selection is one of the most critical aspects for predictable esthetic results in direct and indirect restorations. An accurate color reproduction for restorations and prostheses in the anterior esthetic zone can be challenging when patient expectations from such treatments are high due to the esthetic considerations.[1]

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The shade selection in dentistry uses standard visual shade tabs and advanced instrumental methods. The visual shade selection is a subjective process owing to the variables such as age, sex, type of scale used, clinical experience, degree of light exposure, source of light – artificial/natural, eye fatigue, clearness/opaqueness of teeth, tone of the clinic-neutral/bright, and physiological variables such as possible color deficiency that may lead to inaccuracies.[2]

The advanced instrumental methods provide quantifiable, measurable shade values, decrease visual shade selection errors, and standardize the results.[3] These include colorimeters, spectrophotometers, and digital cameras. The main disadvantage of these advanced instrumental methods is their premium expense, which often keeps them out of the reach of a more extensive section of practitioners. More cost-effective alternatives such as light-correcting devices aim to make the visual shade selection procedure more reliable by significantly reducing procedural errors.[4,5]

The light-correcting device minimizes light interference and allows neutral clarity to assist in the visual method of shade selection by providing a standard light atmosphere. It is a hand-held lamp with the light-emitting diode-based technology with a light source simulating standard daylight (5500k).[6] The device has a light source similar to the most commonly used dental spectrophotometer. It helps correct variations in light conditions, such as the time of the day, the season of the year, and the type of light source in dental offices.[7,8] Light-correcting devices claim to reduce the amount of reflected light to allow for a more accurate assessment of tooth translucency and provide more accurate shade-matching results, thereby reducing remakes, extra appointments, and expenses.[9]

Reliable existing evidence supports using a light-correcting source during tooth shade-matching.[10,11] In the United Kingdom, scientists combined color-correcting and digital recording devices, showing an improved ability to match dental shades compared to the digital device alone under normal light conditions.[10] Another study showed that to standardize light conditions, a daylight lamp may be a valuable aid to significantly improve the ability to match colors as compared to natural daylight.[12,13] In another Irish study, the results indicated that the light-correcting source was the most beneficial factor for shade-taking.[14] Other studies have investigated the reliability of visual shade selection using light correcting devices' use of polarizing filters and evaluated trainees' abilities to perform shade matching at various levels of training.[15-21] Available light-correcting devices in the markets are still expensive and limited studies have investigated the use of newer cost-effective light-correcting devices for clinical shade selection compared with other available methods.

The purpose of the present study was to evaluate the reliability of shade selection using the visual method with an economical light-correcting device (GDP True Light - Shade Matching Light) in clinical shade selection. The null hypothesis was that no significant improvement would be found in the reliability of shade matching using the light-correcting device.

MATERIALS AND METHODS

The study followed an *in vivo* prospective experimental study. Two experienced observers (Dr. N and Dr. S) participated in the study. The study was approved by the Institutional Ethics Committee (IEC) of Christian Medical College and Hospital, Ludhiana (Ref BMHR/IECCMCL/0822-307/Apprvl-ICMR-STS-Proj/CDC). The study sample included 60 volunteers aged 18–25 with an intact maxillary right central incisor and no enamel pigmentation or anomaly. Each observer performed visual shade matching without a light-correcting device and later with a light-correcting device at the same time of the day and in the same dental office after 1 week. The shades were confirmed with the control value obtained using a spectrophotometer (VITA Easyshade

Advance 4.0). Each observer was blinded to the shade color selected by the other examiners.

- Visual method – Shade matching was performed on the middle third of each participant's maxillary right central incisor by using a conventional shade guide (VITA Toothguide 3D-MASTER), first without the aid of a light-correcting device and then with the use of the light correcting device (GDP true light India), after 1 week [Figure 1]
- Instrumental method-Shade matching was performed using a spectrophotometer (VITA Easyshade advance 4.0) [Figure 2]. This value was used as the control shade value.

The data collected were subjected to the statistical analysis. The shade measured with the light-correcting device and without its use was compared with the

control shade obtained by the spectrophotometer. The value closer to the control shade value was considered accurate, and the method used for shade matching would be considered reliable. The Fliess kappa statistical test for multiple measurements assessed method reliability. $P \leq 0.05$ was considered statistically significant.

RESULTS

Sixty participants were enrolled in accounting for any possible exclusions and dropouts. The Fleiss' kappa statistical test was used to assess the reliability of each method. The result indicates that the recordings with light-correcting devices are statistically significantly closer to the control values (spectrophotometer) than the unaided visual shade selection values [Table 1]. Using a light-correcting device to aid clinical shade selection showed more accurate and reliable results ($P < 0.05$) than those recorded with visual shade guides alone. No significant associations were found between the observers in the shade values recorded by the visual method and the visual method using a light-correcting device. Using a light-correcting device significantly increased the reliability of the visual shade selection method compared to the objective shades obtained by spectrophotometer.

DISCUSSION

The null hypothesis that using light-correcting devices would not improve shade selection was rejected. The present study results showed that the light-correcting device recordings were significantly associated with the spectrophotometric ones, as compared to the unaided visual recordings, indicating that using cost-effective light-correcting devices significantly improved the reliability of shade selection and provided similar results to the shade selection values obtained from the standard spectrophotometer device [Table 1]. Similar results were attained in a study wherein the shade-matching scores were highly significant with the light-correcting device compared to natural light.[16]

In the present study, the kappa results showcased no significant associations between observers in the shade values recorded by both observers when using the visual alone or even with the light-correcting device method. However, compared with the spectrophotometer values of the shades recorded for each subject, which is considered the best objective instrumental technique for shade selection, using the light-correcting device as an aid showed more reliable and predictable shade matching ($P < 0.05$) for both observers. This result is similar to the results obtained in the study by Liberato *et al*.[15] This could be likely because the use of light-correcting device helps dampen the surrounding environment light and even helps the observer view the field through a smaller lit area.

The results of the present study have demonstrated that there was reduced inter-observer reliability for dental shade matching. The poor reduced inter-observer reliability may be due to the differences in expertise and eye fatigue among observers.[22] Previous studies have revealed that the natural light condition is one of the most critical features in shade matching skills. This natural light condition can be consistently achieved using light-correcting devices for better shade selection.[23] Light-correcting devices are hand-held, stable light devices with an applied form of balanced light

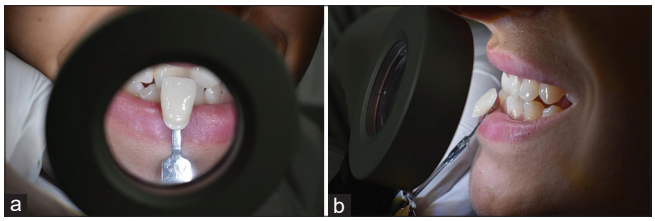

Figure 1: (a and b) Visual shade selection with a light correcting device (GDP True Light).

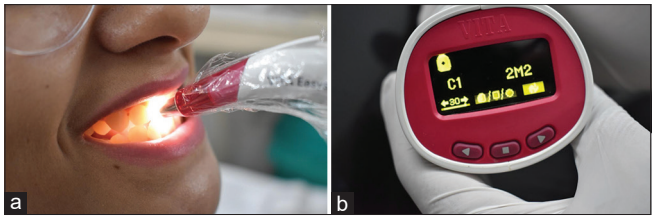

Figure 2: (a) Spectrophotometer-VITA Easyshade advance 4.0 in use to identify the shade of the tooth, (b) quantitative assessment of control shade value.

Table 1: Presents the reliability of the different shade-matching methods

Observer	Dr. S (V)*		Dr. S (T)**		Spectro (Control)	
	Kappa	*P*	Kappa	*P*	Kappa	*P*
Dr. N (V)*	0.050	0.337			0.037	0.399
Dr. S (V)*					0.078	0.092
Dr. N (T)**			0.109	0.067	0.135	0.007***
Dr. S (T)**					0.203	0.0005***

***$P<0.05$; Significant. *V: Visual shade selection; **T: True light device

that enhances the significance of a shade-matching environment.[24] The device included in the study uses an economical design, thereby being available for a more extensive section of dentists, including dental trainees and young graduates, and, at the same time, as shown in the study, is a reliable device for correcting surrounding lighting conditions for accurate shade matching. Studies have previously shown that light-correcting devices improve the shade-matching capability of color-vision-deficient individuals and are promising equipment to aid in shade-matching skills.[25]

The previous study's findings suggest that although the existing light-correcting devices are reliable, as proven in the past, the cost of the devices makes it out of reach for most dental practitioners. The alternative indigenous economic light-correcting devices used in the present study provide a reliable option for shade selection with high efficacy during shade matching. Further evaluation of light-correcting devices compared with the existing light-correcting devices will help us know if there is any difference between the devices concerning shade-matching capabilities. While in the present study, both observers recorded with the visual, unaided method initially, and after a week, with the light-correcting device, there was a risk of carryover effect. This remains a study limitation, which could have been reduced by randomizing the order. Future research among a larger population and using multiple light-correcting devices against the new and improved generations of spectrophotometers and intraoral scanners can be done to evaluate the efficacy of light-correcting devices.

CONCLUSION

Light-correcting devices can aid in reliable shade selection and allow better shade communication with dental laboratory technicians, providing patients with better esthetic outcomes.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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