Repeatability of Instrumental Shade Matching Using Vita Easy Shade Advance V Spectrophotometer

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ABSTRACT

Objectives: To assess the intra-device repeatability in tooth shade matching with the VITA Easy shade advance V spectrophotometer.

Materials and Method: This was a cross-sectional clinical study. Twenty-six teeth (Incisor-Premolar, being in the aesthetic region) that met the selection criteria were included in the study. Spectrophotometric shade matchings of the teeth were done using VITA Easyshade advance V digital dental spectrophotometer following standard protocol. Three consecutive shade readings were taken by the device and recorded for each participant. Data collected were entered into personal computer spread sheet and analysis was done using IBM Statistical Package for Social Science (SPSS) software version 23. The statistical significance was set at <0.05.

Results: A total of twenty-six (26) participants were recruited for the study. There were 11 (42.3%) males and 15 (57.7%) females. Half (50.0%) of the participants were aged 20-39 years. The first and second consecutive shades selected using the spectrophotometer were the same for 13 (50%) teeth. At the second and third consecutive shade selections, the instrument selected identical shades for 20 (76.9%) teeth. In addition, the same shades were recorded by the spectrophotometer for 17 (65.4%) at the first and third shade selection, while same shade reading were gotten for 12 (46.2%) three consecutive times. There was no instance in which all the three shades selected by the spectrophotometer differed. Intra-device reliability for the three consecutive reading measured with Cohen's Kappa coefficient was 0.39.

Conclusion: The VITA Easy shade advance V spectrophotometer consistently selected at least two similar shades in three attempts, but statistically, the agreement was fair.

Running title: Repeatability of instrumental shade matching

INTRODUCTION

Success in colour harmony between dental restoration and closely related natural teeth calls for proper shade selection and reproduction. Therefore, the ability to accurately and consistently match tooth colour is important for provision of aesthetic dental restorations.[1] Tooth shade selection visually is characterized by intra-examiner and inter-examiner variability, as a result of the numerous subjective factors that affect colour selection. The recent tooth shade matching devices that measure tooth colour objectively include dental colorimeter, intra oral scanner, spectrophotometer, spectroradiometer and digital camera.[2] These tooth shade measurement devices can quantify colour and

enable communication between the laboratory and the clinic to be more uniform and precise. In addition, instrumental readings are objective and more rapidly obtained.[3] The newer form of spectrophotometer contains monochromators and photodiodes that measure the reflectance curve of an object's colour every 10nm or less.[4] A spectrophotometer is specific in measuring the colour of an object. The colour measurements obtained by the device are used to automatically select a shade tab from the instrument's database of dental shade guides that has the closest colour measurements.[5]

VITA Easyshade spectrophotometer measures CIELab/CIELCh values and determines the tooth shade based on VITA 3D-Master and VITA classical. It has a 20W halogen bulb that provides a D65 illuminant as professed by the manufacture. Five generations of this device have been released to enhance its capabilities. VITA Easyshade Compact and Advance 4.0 are advanced forms, while the newest generation is termed VITA Easyshade V.[6] When assessments by spectrophotometers are compared with observations made by visual methods, it is believed that these digital devices offer an increased accuracy and a more objective tooth shade match than the traditional visual method.[7,8,9] Farhad et al. reported that dental spectrophotometers offer the highest overall accuracy and precision among different shade selection methods. However, they require a clinical setting to manage relevant influencing factors and conditions, as well as technological enhancements, to achieve optimal performance.

Knezović et al.[10] reported that measuring repeatability was nearly perfect for both in vitro and in vivo models tested (ICCs=0.992-0.994; ICCs=0.858-0.971; respectively). The colour differences for in vitro and in vivo models were high, but at a clinically acceptable aesthetic level (1.25-3.51 ΔE units respectively).[10] Knezović et al. indicated that within the limitations of their study[10], VITA Easyshade® Advance 4.0 dental shade-matching device enabled reliable and accurate measurement, which can be a valuable tool for the determination of tooth colours. However, there is scarcity of study in our environment regarding the repeatability of the VITA Easyshade advance Spectrophotometer in a clinic setting and the few of them that exist are more of in vitro studies. Therefore, this current study set out to assess the repeatability of the VITA Easy shade advance V spectrometer in matching tooth shade clinically.

METHODS

This was a cross-sectional clinical study. Twenty-six teeth (Incisor-Premolar, being in the aesthetic region) that met the selection criteria were included in the study. The study excluded participants with discoloured teeth, those who had previously received tooth bleaching treatments, individuals wearing orthodontic appliances, and those with impractical aesthetic expectations. Sociodemographic data of the participants including age, gender, level of education and marital status was recorded. Ethical approval (UI/EC/17/0507) was obtained before the commencement of the study. Written and duly signed informed consents were also taken from all the participants. Participants had scaling and polishing done prior to the shade matching procedure.

Spectrophotometric shade selection of the teeth was done using VITA Easyshade advance V digital dental spectrophotometer (Vasa Denticity Private Limited. Ghitorni, Delhi, India.). The principal investigator trained on the use of the device earlier to the commencement of the shade selection procedure. The VITA Easyshade device was calibrated according to the manufacturer's specification and set at VITA classical shade guide mode. Shade was taken with the probe of the device covered with the disposable infection control shield for each participant to prevent cross infection, and other infection control protocols were strictly adhered to.

The device probe was positioned firmly on the middle third of the tooth perpendicular to its surface. The activation button on the handle of the instrument was pressed until beeping sound was heard to confirm that measurement was completed. Three consecutive readings were taken and recorded for each participant.

Data analyses

Data collected was entered into personal computer spreadsheets and analysis was done using IBM Statistical Package for Social Science (SPSS) software version 23. Normalcy of the data was assessed using Kolmogorov-Smirnov test and found to be normally distributed. Descriptive statistics including frequency, means and standard deviation were used to report parameters. Intra-device reliability for the three consecutive shade reading was measured using Cohen's Kappa coefficient.

RESULTS

A total of twenty-six (26) participants were recruited for the study. There were 11 (42.3%) males and 15 (57.7%) females. Half (50.0%) of the participants were aged 20-39 years, 23.1 % were 40-59 years while the rest (26.9%) were 60 years and above. Majority (76.9%) of the participants had tertiary education followed by secondary education (19.2%) while only one individual (3.9%) had primary education. (Table 1)

Table 1: Bio data of participants

	Frequency	Percentage
Gender	N= 26	(%)
Male	11	42.3
Female	15	57.7
Age group (years)		
20-39 years	13	50.0
40-59 years	6	23.1
≥ 60 years	7	26.9
Educational level		
Primary	1	3.9
Secondary	5	19.2
Tertiary	20	76.9

The first and se ond consecutive shades selected using the spectrophotometer were the same for 13 (50%) teeth. (Table 2)

Table 2: Tooth shades selected first and second time

Participants	First shade selection	Second shade selection
1	D3	C3
2	D4	C4
3	C2	A2
4	A2	C2
5	**C3**	**C3**
6	**C4**	**C4**
7	C3	C3
8	D4	A4
9	C3	C3
10	A2	A2
11	A3	C3
12	A3.5	A3.5
13	C4	C4
14	C4	C4
15	A1	B2
16	B3	B3
17	A2	A2
18	A4	A3.5
19	C4	C4
20	C1	B2
21	A4	A3.5
22	C3	A4
23	A3.5	A4
24	B4	B4
25	A3	D3
26	A3	A3

At the second and third consecutive shade selections, the instrument selected identical shades for 20 (76.9%) teeth. (Table 3)

Table 3: Tooth shades selected second and third time

Participants	Second shade selection	Third shade selection
1	C3	D3
2	C4	C4
3	A2	A2
4	C2	C2
5	C3	A4
6	C4	C4
7	C3	C3
8	A4	A4
9	C3	C3
10	A2	A2
11	C3	A3
12	A3.5	A3.5
13	C4	C4
14	C4	C4
15	B2	B2
16	B3	B3
17	A2	A2
18	A3.5	A4
19	C4	C4
20	B2	B2
21	A3.5	A3.5
22	A4	C3
23	A4	A4
24	B4	B4
25	D3	A3
26	A3	A3

In addition, the same shades were recorded by the spectrophotometer for 17 (65.4%) at the first and third shade selection (Table 4), while same shade readings were gotten for 12 (46.2%) three consecutive times (Table 5). There were none of the cases in which all the three shades selected by the spectrophotometer differed. Intra-device reliability measured with Cohen's Kappa coefficient was 0.39.

Table 4: Tooth shades selected first and third time

Participants	First shade selection	Third shade selection
1	D3	D3
2	D4	C4
3	C2	A2
4	A2	C2
5	C3	A4
6	C4	C4
7	C3	C3
8	D4	A4
9	C3	C3
10	A2	A2
11	A3	A3
12	A3.5	A3.5
13	C4	C4
14	C4	C4
15	A1	B2
16	B3	B3
17	A2	A2
18	A4	A4
19	C4	C4
20	C1	B2
21	A4	A3.5
22	C3	C3
23	A3.5	A4
24	B4	B4
25	A3	A3
26	A3	A3

Table 5: Tooth shades selected three consecutive times

Participants	First shade selection	Second shade selection	Third shade selection
1	D3	C3	D3
2	D4	C4	C4
3	C2	A2	A2
4	A2	C2	C2
5	C3	C3	A4
6	C4	C4	C4
7	C3	C3	C3
8	D4	A4	A4
9	C3	C3	C3
10	A2	A2	A2
11	A3	C3	A3
12	A3.5	A3.5	A3.5
13	C4	C4	C4
14	C4	C4	C4
15	A1	B2	B2
16	B3	B3	B3
17	A2	A2	A2
18	A4	A3.5	A4
19	C4	C4	C4
20	C1	B2	B2
21	A4	A3.5	A3.5
22	C3	A4	C3
23	A3.5	A4	A4
24	B4	B4	B4
25	A3	D3	A3
26	A3	A3	A3

***Shaded rows= same shades selected three times in 12 cases (46.2%)**
Intra-device reliability measured with Cohen's Kappa coefficient = 0.39

DISCUSSION

An aesthetic and comfortable restoration lessens patient's concerns and improves their quality of life. It is therefore paramount that the shade of the restoration matches that of adjacent natural teeth especially in the anterior aesthetic region. Correct shade selection of restoration for anterior teeth has been a challenge in dental clinics over the years due to subjectivity of the visual methods in use.[11-13] Visual method of shade selection is the most commonly used generally and the objective or instrument method is very expensive, while the devices have varying degrees of reliability and validity. The device can generate colour coordinates (Tristimulus values) and/or categorically select tooth shade as done in this study. The current study was intended to assess the repeatability of the VITA Easy shade advance V spectrometer in matching tooth shade under clinical condition. The manufacturer recommends three measurements, two of which must be identical. For clinical purposes, if the first two attempts are identical, there is no need for the third, and if the first two readings are different, the first and the 3rd should not, otherwise, the device is not reliable. Although dental spectrophotometer is more sophisticated compared to other devices such as colorimeter and intra oral scanner, its reliability and repeatability is still somehow questionable especially in a clinical situation. Manufacturers of colorimeters and spectrophotometers have incorporated standardized illumination which are alleged to be unaffected by the ambient light from the Dental Surgery. Conversely, ambient light has been said to affect colorimetric measurements.

Findings from this present study observed identical shade selection by the spectrophotometer in half (50%) of the cases in first and second consecutive selections. This is in agreement with the study[14] of Ebeid and Sabet who reported less than 55% repeatability for the evaluated devices. The same shade match was recorded in second and third consecutive

shade matching in majority of cases (76.9%). This result was similar to the findings of Gehrke et al. (2009) that took two consecutive shades by spectrophotometer and 81.7% matches of first and second readings were demonstrated.[15] Reasons for the slightly higher level of agreement between the first and second consecutive reading in the study of Gehrke et al.[15] compared to this study may be due to the different clinical condition and the different brands of the spectrophotometer used. A shade pilot was used as against the VITA Easyshade advance V that was used in the present study. There was a considerable agreement of the three successive readings of the spectrophotometer in 12 cases (46.2%), intra-device reliability obtained with Cohen's Kappa coefficient was 0.39. This finding was buttressed by the study of Paul et al.,[16] in which all three spectrophotometric shade selections in 9 (90%) out of 10 cases matched, although, by this, there was higher agreement in their study with fewer sample size of 10 patients.

Advance spectrophotometer is more reliable to use, even among the other instrumental methods in shade selections as seen in this study. A study by Okubo et al.[17] reported no significant difference in precision rates between visual shade selection (48.5%) and colorimeter (50%) methods, despite that colorimeter is an instrumental method. Igiel et al.[18] revealed that there was good to excellent inter-rater reliability for spectrophotometric method. The mathematical background of the spectrophotometric shade assessment and improvement in standardization of the measuring procedure compared to visual observation may be accountable for the better reliability. The negative effect of some human factors such as fatigue and subjectivity of perception which are absent in the spectrophotometer might have been responsible for better repeatability. Mohamad et al.,[19] observed in their study that instrumental shade selection with spectrophotometer was more repeatable than the visual method, however, the repeatability of visual method was influenced by the operator's experience. Hampe-Kautz et al.,[20] also reported that both Rayplicker and Easyshade V spectrophotometer studied have excellent reliability in recording the fundamental aspects of colour, with notably high repeatability in recording the lightness, chroma, and hue parameters.

Repeatability measurements enable an evaluation of the consistency of the shade-matching device in making repeated measurements of the same shade tab[10,21], which was satisfactory in this study using VITA Easyshade advance V spectrophotometer. In this study, two identical measurements were recorded in all the cases; therefore, for clinical purposes, the instrument is highly reliable, but statistically, the level of agreement is fair.

CONCLUSION

VITA Easy shade advance V spectrophotometer consistently selected at least two similar shades in three attempts, but, statistically, the agreement was fair.

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