ORIGINAL RESEARCH

Role of Digital Photography as a Tool for Shade Selection in Prosthodontics

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ABSTRACT

Statement of problem: Shade selection remains as a challenge for any restorative dental procedures. There is a need to check for the reliability of methods used in shade selection for a successful restorative treatment.

Aim: The aim of this study was to compare the reliability of two different methods used for shade selection, i.e.; visual method and digital photography method.

Materials and methods: Fifty-two student participants of age group 18-25 years were selected for the study from our institution after obtaining informed consent. The only inclusion criteria for the study were the presence of an unrestored maxillary right central incisor. The shade of the right maxillary central incisor was determined by visual and digital photography method. In visual method, the shade was selected by the clinician using shade guide (vita classical shade guide) and the shade was manually entered. In digital photography method, the digital camera was used (eye special c iii dental camera). Standardized digital photographic images were taken and sent to a dental technician. The reliability of the perception of the clinician selected shade by visual method and the technician selected shade by digital method were compared and evaluated after being subjected to appropriate statistical analysis.

Results: On comparison of the two different methods of shade selection, there was fair agreement between the two methods of shade selection.

Conclusion: Digital camera can be used for shade selection as it improves communication between the dentist and dental technician and with further advancements in digitalisation, it may replace the visual method in the near future.

Keywords: Digital method, digital photography

INTRODUCTION

Over the recent years, the demand for aesthetic restorations has become the order of the day. Shade selection plays a vital role in determining the aesthetic outcome of a prosthodontic restoration. Shade selection is a strenuous and exigent task. The difficulties encountered during shade selection are mainly due to the lack of systematic arrangement between the shade tabs and lack of adequate communication between the dentist and technician.[1] Due to the presence of numerous varieties of natural tooth shades among humans[2] achieving a close match in dental restoration with the natural dentition is a complex process. There is a need for standardisation of shade selection technique with constant reliability. Among the various reasons for ceramic restoration failure, improper shade selection has been the second most commonly quoted reason.[3]

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The selected shade for the restoration should simulate the natural tooth colour and texture within acceptable ranges. Shade selection is influenced by several factors.[4] External factors such as the surrounding illumination, the tooth, dentist's and patient's personal perception of shade and variables such as age and gender are critical factors as they interfere with shade matching procedure.[5,6] Most common causes for a fixed dental restoration to fail is shade mismatch. The methods used for shade selection are the conventional visual method using shade tabs, and the instrumental method using colour measuring devices. Traditionally the visual method of shade selection was followed in clinical set up. It is a simple method but is more prone to errors as it is subjective. In addition to this, there is lack of systematic arrangement of shade tabs with respect to hue, value and chroma.[7] Over the years, many instruments were fabricated/modified for shade selection.[3]

These instruments include the spectrophotometer, colorimeter, spectroradiometer and digital camera. Instrumental tooth color measure is an unbiased and appraised data that matches natural teeth to clinical shade guides.[8] These have their own limitations such as inability to read complex translucent objects, due to software which use dissimilar algorithms and inability to control all variables.[9]

Modern day advent in photography and computer technology has resulted in the widespread use of digital camera which can be used for shade selection. Digital camera records digital data from an object which may subsequently used to produce a digital image. This image can then be transmitted via the internet[1]. Digital photographs reduce errors in recording and convenient for usage. Failures in FPD's can be prevented by adequate communication with the lab. This recent advancement in the use of digital camera can improve the means of communication in terms of shade selection between the dentist and the dental technician.[10] In light of the above, this study was aimed to compare the reliability of two different methods used for shade selection, i.e.; visual method and digital photography method in clinical set up.

MATERIALS AND METHODS:

Fifty-two student participants of age group 18-25 years were chosen for this study. The inclusion criteria were that the participant must have an unrestored right maxillary central incisor. Exclusion criteria included participant not willing for the study, presence of restored or missing maxillary right central incisor, patient with dental fluorosis or stained teeth.

fter obtaining the ethical committee approval for the study, fifty-two student participants were randomly selected from our Institution. Informed consent was obtained and only those who were willing were included in the study. Shade selection was done to evaluate the visual and digital method in the clinical set up by the clinician and dental technician.

Shades were selected in a standardisation setup, where a monochromatic white background was used. All shade matching was performed by a single clinician to prevent inter-operator bias. The participant was made to sit on a chair at a distance of 1 feet from the white background as per the specifications as given in the digital camera manual. In between every shade matching, to avoid colour fatigue, the clinician deprogrammed her vision by looking at a blue sheet for 5s.[4]

VISUAL SHADE SELECTION

VITAPAN classical shade guide (Figure.1) (VITA Zahn Fabrik H. Rauter GmbH and Co, KG, Bad Sackingen, Germany) was used for all the participants. Middle third of the right maxillary central incisor was selected.[3] Teeth were dampened by asking subject to rinse with water. Initially, the hue was selected from nearest shade colour available following which Chroma was selected from within hue group based on saturation of colour[3].After the shade is selected by the clinician, the selected shade tab along with the patient tooth on which the shade has to be determined was photographed. (Figure.2).

DIGITAL SHADE SELECTION

EYESPECIAL CIII (SHOFU Dental Corp Dental) Camera[11](Figure.3) was used in our study. This camera is designed exclusively for dental photography. It has high performance 49 mm close-up lens. It has many working modes, one among which is the Isolate Shade Mode,wherein the shade can be isolated for optimal shade matching. It is compatible with wireless memory card and henceforth the images can be instantly transferred and uploaded on to a tablet, computer or smart Phone. The camera parameters followed for each participant is listed in (Table1). For taking intraoral image, the camera was placed on a tripod stand at a distance of 23.8 cm from the patient to record a dimensionally stable image as per the standard instructions of the camera. When photographed, two images were produced. The first is a colour image (Figure.4) and automatically second image is generated by this camera. This image masks the colour of gingiva and soft tissues except the teeth. (Isolate shade mode) (Figure.5).

After the images were uploaded on the computer, the shade matching was done by the technician and the values were noted. The technician was blind folded regarding the shade selected by visual method by the clinician.

STATISTICAL ANALYSIS:
Agreement between visual and photographic method was checked. Cohen kappa statistics was used to check for inter-rater reliability of shade matching performance.

RESULTS:
In this study, a combination of data obtained among the 52 participants was tabulated [Table 2]. The agreement between visual and digital photographic methods were assessed using cohen kappa statistics. The value obtained was 0.268. Results obtained had a "fair" proportion of "yes" (agreement). [Table 3]. For Shades obtained by visual and digital method, high percentage of agreement was seen for A2 Shade (36%) followed by A1 (11%) and least for A3(7%) shade. [Table 4].

DISCUSSION:
Amicable relationship between the shade of the restoration and natural tooth is of due importance and demand for most of the patients. Aesthetics is one prime factor that determines the success of a prosthodontic restoration. There is a need for reliable method of shade selection for standardization of the shade matching procedure. The visual method of shade selection was one of the oldest methods of shade selection.[3] It was however unreliable and inconsistent[12] as it is subjective and can be influenced by external factors. The popular shade guides include VITA Classical, Chroma Scope, Vitapan 3D Master shade guide.[2] These shade guide has obvious inadequacies.[13] Through the years, Instrumental means of shade selection such as spectrophotometer and colorimeter and digital camera were developed.[14] These were objective and was able to overcome the subjective error of visual method of shade matching. With increasing advent in cosmetic dentistry, there is an increased need of demand to switch over to instrumental method of shade matching.[3]Professional experience is shown as one of the important factors on color perception.[15]Alshiddi et al[16] compared the accuracy of shade selection using Spectrophotometer with conventional visual method among trained and untrained dental students. From his studies, he concluded that spectrophotometric device is more accurate than the conventional visual method, especially for the inexperienced, and with proper knowledge of colour and training, improved visual shade matching can be made possible among inexperienced students.

Tam et al study[17] was based on the use of smart phone camera for shade matching. In his view, smart phone can be used color reference in dental shade matching and it enhances the dentist technician communication. Clinicians should be aware of the shade selection methods they chose due to the complex nature of colour, polychromatic structure of teeth and the variations in individual's subjective perception of color.[18]In our study, we have compared and evaluated the reliability between the visual and digital photographic method of shade matching. Initially the shade matching was done visually using shade tab by the clinician and the shade obtained were noted (Vita Classic).

The pre-set modes for capturing images of the Eye Special C-III allows for easy usage with favourable results and homogenous quality of image.[11] One among the eight modes is the isolate shade mode.In previous studies by Miyajiwala et al,[3]gray card which is a neutral target was used as a standard coloured object in digital photography method to obtain comparable results.[1] However, in this study, gray card was not used. The camera automatically generates an image in which the colour of the gingiva and the surrounding soft tissues except for the tooth is masked.On comparing the reliability between the two methods, there were more percent agreement with A2 shade(57.6%) followed by A1 shade (54.5%).On comparing the coefficient of kappa statistics, there was a fair agreement between the two methods. Results of this study reflected on the percent agreement between the visual and digital method of shade selection which is statistically fair. Similar data findings were found with studies by Miyajiwala et al.[3] However, the percent agreement would have been more reliable with the participation of more than one dental technician. Chu et al[19] from his study stated that digital cameras can be an ideal supplement but not a very reliable method for shade analysis. DSLR cameras incorporated with acceptable accuracy protocols showed potentiality for use in color replication process.[20]

Digital camera can also substitute colorimeters for assessing shade if proper-object camera distance, digital camera settings are followed and suitable illumination conditions are available.[21] The results of this study convey the need for combining the visual method of shade selection with the digital method to aid as a better and effective means of communication between the dental clinician and laboratory technician. It can also evolve as a reliable and standard method. In all possibility, a method which combines both the instrumental and visual method often provides a foreseeable aesthetic result.[22]

In addition, systematic education and training need to be imparted to laboratory technicians involved in production of aesthetic and accurate restorations.[23] The limitations of this study are the shade matching was done by a single dental technician and the results would have been more reliable if the study was done by more than one dental technician. The digital colour analysis of shade guides of the same manufacturer was found to be different in daylight as well as in studio environments.[25] The sample size is small, due to which there are more chances for statistical errors. Munsell colour blindness test was not done for the operator. It is mandatory for the operator to undergo Munsell colour blindness test to avoid possibility of errors from colour blindness and for the study results to be more reliable. Other limiting factors would be the variability in the level of knowledge of shade selection among different dental technician and variable results obtained with the different types of shade guide. Future studies should focus more on the reliability of use of digital camera as an instrumental aid in shade selection taking into consideration the limitations of this study.

SUMMARY:

Shade matching being the pivotal determinant for the success of any esthetic restoration must be in harmony with the patients existing dentition. The human perception of color is complex and encompasses both subjective and objective phenomena.[24] Dental practitioner needs an understanding of colour, light and in addition to this, there should be good level of communication with the lab technicians to obtain natural aesthetic looking restoration. In this study, the reliability of shade selection method by visual and digital method was evaluated. There was a fair percent of agreement between the visual and digital method of shade selection. In this robotic era, the use of digital camera for shade selection would be more comfortable and time saving and would emerge as viable option for improving the dentist- laboratory communication.

Table1: Camera Settings

PARAMETERS	SETTINGS SELECTED
Magnification	1:1.5 ratio selected
ExposureMode	Automatic
WhiteBalance	Automatic
Flash	TTL* Flash metering
Aperture	Automatic
Image resolution	High image resolution selected
File type	JPEG Format
ISO* Value	Automatic

ISO* - International Organization of Standardization, TTL*-Through the lens.

Table 2: Shade selection Results (52participants)

S.NO	MANUAL METHOD OF SHADE SELECTION	DIGITAL METHOD OF SHADE SELECTION	AGREEMENT
1	A3	A2	NO
2	**A2**	**A2**	**YES**
3	**A2**	**A2**	**YES**
4	A2	A3	NO
5	A2	A3	NO
6	A2	A1	NO
7	**A2**	**A2**	**YES**
8	A2	A1	NO
9	A2	A3	NO
10	**A2**	**A2**	**YES**
11	A2	A1	NO
12	**A2**	**A2**	**YES**
13	A1	A2	NO
14	**A3**	**A3**	**YES**
15	**A2**	**A2**	**YES**
16	A3	A2	NO
17	**A2**	**A2**	**YES**
18	**A1**	**A1**	**YES**
19	A3	A2	NO
20	A2	A1	NO
21	**A2**	**A2**	**YES**
22	**A2**	**A2**	**YES**
23	A2	A1	NO
24	**A1**	**A1**	**YES**
25	**A2**	**A2**	**YES**
26	**A2**	**A2**	**YES**
27	**A1**	**A1**	**YES**
28	**A2**	**A2**	**YES**
29	A3	A2	NO
30	**A2**	**A2**	**YES**
31	**A3**	**A3**	**YES**
32	A2	A1	NO
33	A1	A2	NO
34	A3	A3.5	NO
35	A1	A2	NO
36	**A2**	**A2**	**YES**
37	A2	A1	NO
38	**A1**	**A1**	**YES**
39	A1	A2	NO
40	**A2**	**A2**	**YES**
41	A2	A3	NO

42	**A2**	**A2**	**YES**
43	**A1**	**A1**	**YES**
44	**A3**	**A3**	**YES**
45	A2	A1	NO
46	**A2**	**A2**	**YES**
47	**A3**	**A3**	**YES**
48	A2	A1	NO
49	**A2**	**A2**	**YES**
50	**A2**	**A2**	**YES**
51	A1	A2	NO
52	**A1**	**A1**	**YES**

Table 3: Symmetric Measures of agreement between Manual and Digital Method

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	.268	.120	2.646	.008
N of Valid Cases		52			
a. Not assuming the null hypothesis.					
b. Using the asymptotic standard error assuming the null hypothesis.					

Table 4: Percentage of samples with similar scores (accuracy) between manual and digital method

Shade	n (%)
A1	6 (11%)
A2	19(36%)
A3	4(7%)
TOTAL AGREEMENT	29(54%)

Conflict of Interest: Nil

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