DOI: 10.7860/JCDR/2026/81548.23418

Original Article

Dentistry Section

Inter-rater Reliability of Tooth Shade Selection by Conventional Visual Method and Intraoral Camera: An In-vivo Study

SUNETRI MONDAL[1], SAMIRAN DAS[2], JAYANTA BHATTACHARYYA[3], SHUBHABRATA ROY[4]

ABSTRACT

Introduction: Visual shade matching has been practiced in dentistry for decades to find a shade of restoration that perfectly match with adjacent tooth for natural aesthetic look. Intraoral camera is an adjunct tool for visual shade matching that can reduce the shortcomings of conventional method. It is especially beneficial for subjective shade matching with in-built optimal lighting conditions while eliminating all environmental influences. The study's rationale is to determine whether or not external lighting and background affect a clinician's visual shade-matching performance.

Aim: To determine the inter-rater reliability of shade matching by conventional visual method and using intraoral camera (SOPRO 717) assisted visual method, while taking account into the environmental influence on visual shade matching.

Materials and Methods: The study was conducted in-vivo in the Department of Prosthodontics, Guru Nanak Institute of Dental College and Hospital in Kolkata West Bengal, India, over a period of 18 months from May 2022 to November 2023. Five dental professionals with normal colour vision performed the shade selection procedure on 30 patients of 24 to 60 years. Each dental professional or examiner matched the shade of tooth with VITA System 3D-Master® shade guide by conventional visual method and with intraoral camera; before and after the insertion of restoration. Chi-square test was used to determine the reliability among examiners and p-value<0.05 was considered to be statistically significant.

Results: When two methods were compared, it showed that shade selection using intraoral camera was more aligned with the selected shades based on consensus than conventional method. The Chi-square statistic was 24.6544. The p-value was <0.00001 (significant at p<0.05). Reliability among five raters or examiners showed statistically significant difference (p<0.05) for conventional visual method indicating less agreement level among examiners. Whereas agreement level was higher for intraoral camera.

Conclusion: Intraoral camera is a reliable assistance for visual shade selection as it reduces certain level of subjectivity and help the observer for easy decision making by increasing the agreement level.

Keywords: Accuracy, Colour matching, Dental aesthetic, Environmental influence, Light, Shade guide

INTRODUCTION

In aesthetic dentistry, an integral part is colour component which is undoubtedly the most complex and least understood. It is an aspect with numerous interdependent factors; all of these contribute to the final aesthetic outcome. Although complex, a basic knowledge of the various components of colour is imperative to produce successful aesthetic outcome. Ultimate goal of shade selection in dentistry is to recreate the natural appearance or to enhance aesthetic of natural oral structure by different restorative materials. Shade selection procedure can be visual or instrumental; among these methods, visual method is the most frequently used methods since many years in which colour of restoration is determined by comparing the tooth colour with a colour standard. "Being the oldest and most frequently used method of shade selection in dentistry, visual colour assessment is considered too subjective and inconsistent by individual dentists. Human colour perception also depends on ageing, gender, ocular fatigue, clinician colour deficiency, integrity and functioning of ocular and cerebral levels. In addition to the fact that critical colour perception varies from one individual to another human eye variables and the frequent inadequacy of available shade guides cause a certain inability to reliably duplicate shade selection from one day to another" [1,2].

Standard lighting condition is crucial for visual shade matching as under different light source same object can be seen with different shades. Ideally, the light source should be equivalent to daylight in Washington District of Columbia (Bureau of Standards) in the month of June, during the hours of 12:00 noon to 1:00 PM, when there is slightly overcast sky; the Colour Rendering Index (CRI) of this light source should be 90 or higher which can be created artificially with an illuminant of 6500 K colour temperature and keeping the light intensity between 1200 and 1400 lux [3,4]. Also, there are some uncontrolled factors such as background and the reflected light from surrounding coloured objects which influence the visual shade assessment. A conscientious dentist should not rely solely on a visual assessment of tooth shade and commercial shade guide, but also on adjunct tools to remove a certain level of subjectivity and environmental influences [5]. Digital shade matching devices like colourimeter, intraoral camera which are used as adjunct tools in shade matching. The SOPRO 717 (Acteon group, France) intraoral camera is a tool which assists in visual shade selection. This intraoral camera has its own illumination, so it is not dependent on the environmental lighting condition [1]. Through this device, a significant enlarged image can be transferred to a computer screen or TV screen display. The image of the tooth can be captured in one half of the screen and another half can be used for comparing different shade tabs. Thus, it can simplify the visual shade matching procedure. The manufacturers claim that these devices exhibit high accuracy and trueness. The intraoral camera is especially beneficial for subjective shade matching with in-built optimal lighting conditions while eliminating all environmental influences.

The study's rationale is to determine whether or not external lighting and background affect a clinician's visual shade-matching performance. Hence, the study aimed to evaluate inter-rater reliability of tooth shade selection by conventional visual method and intraoral camera considering the environmental influence in visual shade selection. The null hypothesis is that there is no significant

difference in shade matching performance between visual shade selection following the proper shade matching protocol and shade selection using an intraoral camera after eliminating all extraneous influences. The alternate hypothesis is that there is significant difference in shade matching performance between visual shade selection following the proper shade matching protocol and shade selection using an intraoral camera after eliminating all extraneous influences.

MATERIALS AND METHODS

The in-vivo study was conducted in the Department of Prosthodontics, Guru Nanak Institute of Dental College and Hospital in Kolkata West bengal, India, over a period of 18 months from May 2022 to November 2023, after obtaining Institutional Ethical Committee approval (IEC no: GNIDSR/IEC/21-24/04) with informed consent from study participants.

Inclusion and Exclusion criteria: Patients within the age group of 24 to 60 years, who needed metal ceramic restoration of maxillary anterior tooth were selected randomly from the pool of potential study participants who came for treatment in the department of Prosthodontics and Crown and Bridge. Patients who had all anterior teeth and needed single metal ceramic restoration in anterior tooth within the age of 24 to 60 years were included. Those with pathological discolourations (tetracycline aetiology) or missing tooth or any existing crown in anterior region were excluded.

Study Procedure

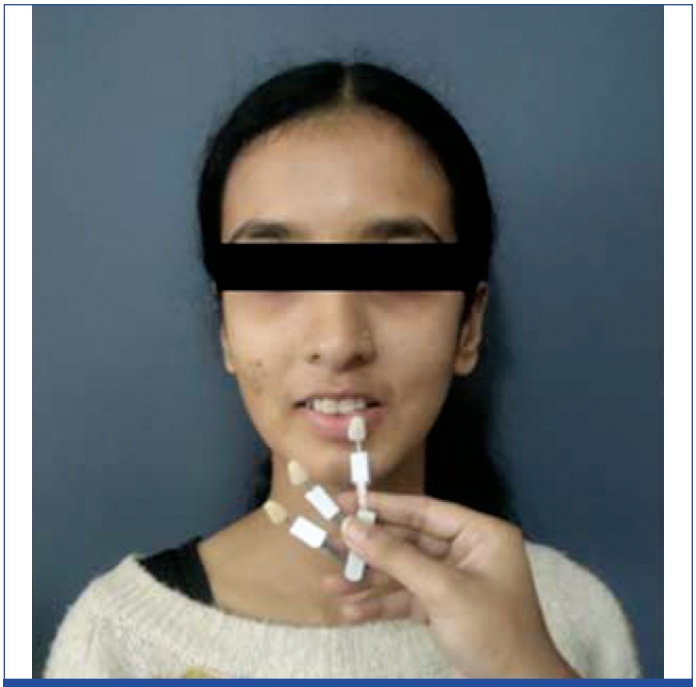
Five dental professionals (Postgraduate Trainee) within the age group of 20-30 years, who had minimum two years of clinical experience, performed the shade selection procedure on 30 patients. To avoid potential defective colour vision, visual acuity of examiners was screened by their ability of correctly identifying the selected plates from Ishihara chart. All five appeared to be free of any colour vision deficiencies. Few days before the experiment of shade matching, examiners were given a presentation on colour science and dental shade matching procedures which was then reviewed with the examiners to confirm that they understood the principles and procedure of shade matching.

Before the evaluation, in every case teeth were cleaned and polished using polishing paste and brushes. After that, the patients were instructed to rinse their mouth. Each dental professional or examiner matched the shade of tooth with VITA System 3D-Master® shade guide by conventional visual method. Again, using the intraoral camera, they were instructed to match the shade of tooth and asked whether they wanted to choose a new shade tab or wanted to stick to the previous shade tab and there was break in between to avoid recall bias. These procedures were performed prior to restoration of tooth and after each selection the patients were told to moisten their teeth with their tongue to avoid desiccation. To avoid bias, the target tab handle's shade nomenclatures were hidden.

For visual shade matching, an illuminant with colour temperature 6500K was used to create natural day light. Illumination angulation was 45°. Luminescence of light source was checked by the lux meter. The light intensity was adjusted to 1200-1400 lux [3,4].

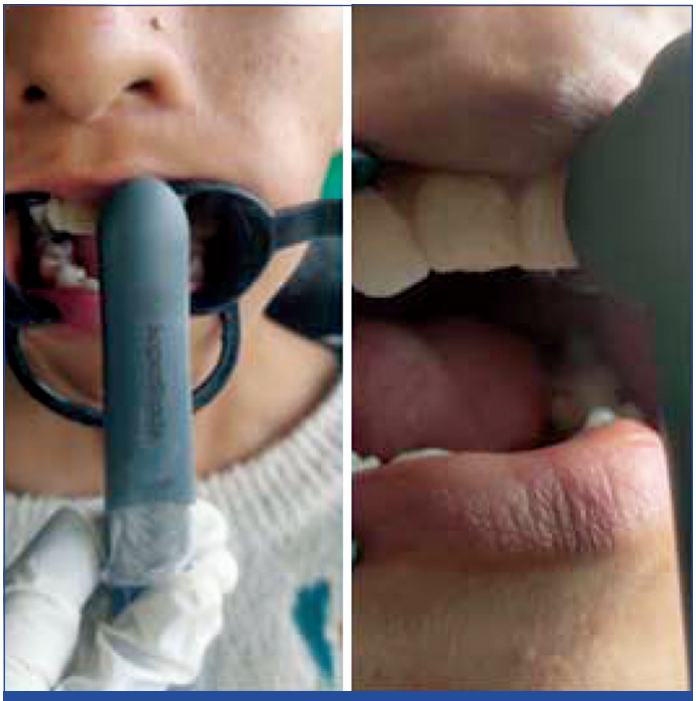
During procedure, each patient was in an orthostatic position, with the head stabilised and the background was neutral gray in colour [Table/Fig-1]. For visual shade matching, shade was selected within five seconds to avoid fatigue of eye. Examiners were told to look at blue card in between selection procedures.

For shade matching with intraoral camera, selection was done with the SOPRO 717 intraoral camera [Table/Fig-2]. Before using the intraoral camera, calibration was done for accurate results. Specifically designed tips for the incisors and canines, were used for better adaptation [Table/Fig-3]. Every captured image of tooth was visualised on computer screen and split into two equal sections.



[Table/Fig-1]: Visual shade selection.

[Table/Fig-2]: SOPRO 717 Intraoral camera with specially designed tips for incisors and canine.



[Table/Fig-3]: Tip of intraoral camera adapted to central incisor.

Then the remaining half of the Vita 3D-Master shade tabs image was then compared with the half of the teeth image that was still visible on the screen [Table/Fig-4].

[Table/Fig-4]: Captured image on laptop screen.

Finally, when the shade was selected, the image with tooth and selected shade tab was saved in the system with patient's name and particulars. Tooth shades selected by each dental professional by conventional visual method and using intraoral camera, were tabulated for each restoration. Then the most frequently selected shade from the tabulated chart (Inter-rater agreement) was selected. For a single restoration total 10 shades were selected by five examiners in which five shades were by conventional visual method and five shades with intraoral camera and the shade of PFM crown was decided with a consensus opinion among selected shades by five raters or examiners. Thus, for 30 patients total 300 shades were selected among which 150 was by conventional visual method and 150 with intraoral camera.

After the insertion and cementation of metal ceramic restoration on the anterior tooth, examiners performed the visual shade matching of this restoration again in same light intensity, same illuminant and same conditions following the protocols as previously done. Selected shades by each examiner were tabulated. On the same day, shade matching of the PFM crown was also done with intraoral camera (SOPRO 717) and selected shades of five examiners were tabulated.

To check the intra-rater reliability or repeatability of visual shade matching, again a visual shade matching of this restoration was performed after seven days, following the same condition and protocols as previously done. Selected shades were tabulated and analysed statistically.

For more detailed findings, three components of each shade tab of VITA System 3D-Master® shade guide representing value (number), hue (letter) and chroma (number) were considered. So, five examiners selected total 150 shades with conventional method after insertion of crown; among those selected shades, correctly selected shades and correctly selected value (only the value, ignoring the hue and chroma) were compared. Similarly with intraoral camera, selected 150 shades were compared for correctly selected shade and value component.

Methods	Aligned with the final selected shades	Not aligned with the final selected shades	Total shade selection	Chi-square value	p-value
Conventional visual shade selection	54	96	150	24.6544	<0.00001
Shade selection using intraoral camera	97	53	150		
Total	151	149	300		

[Table/Fig-5]: Comparison of shades selected by conventional visual shade method and intraoral camera method with the final shade of restoration (based on consensus).
Chi-square test. The chi-square statistic is 24.6544. The p-value is <0.00001 (Significant at p<0.05)

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software (IBM Corp 2013; version 22.0; Armonk, NY). Chi-square test was used to decide in which method shades are more aligned with the final selected shades and also, to determine the reliability among examiners. A p-value< 0.05 was considered to be statistically significant. Cohen's Kappa test was used to determine the intra-rater reliability.

RESULTS

The comparison of two methods i.e., conventional visual method and intraoral camera assisted visual method is depicted in [Table/Fig-5]. Shades selected by these two methods have been tabulated as aligned and non aligned according to similar or dissimilar shade selection with the shade of PFM crown and Chi-square test has been used for statistical analysis. Shade selection using intraoral camera is more aligned with the selected shades based on consensus.

During the shade selection procedure for the metal ceramic restoration; the reliability among the five raters showed statistically significant difference when conventional visual method was used indicating that agreement level is less for this method [Table/Fig-6]. For intraoral camera, the reliability among the raters was found statistically non significant which implies higher agreement level when visual method is assisted by intraoral camera [Table/Fig-7].

Overall success rate of visual shade selection of five raters was 27.33 % and for the camera-assisted method was 34% shown in [Table/Fig-8]. Though the accuracy was higher in intraoral camera

By conventional visual method	Examiner 1	Examiner 2	Examiner 3	Examiner 4	Examiner 5
	n (%)	n (%)	n (%)	n (%)	n (%)
Agree	18 (60.0)	8 (26.7)	9 (30)	9 (30.0)	10 (33.3)
Disagree	12 (40.0)	22 (73.3)	21 (70)	21 (70.0)	20 (66.7)
Total	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)

[Table/Fig-6]: Reliability among the examiners by conventional visual method.
Chi-square value=9.664; p-value=0.046 Significant
Statistical Analysis: Chi-square test

With intraoral camera assisted visual method	Examiner 1	Examiner 2	Examiner 3	Examiner 4	Examiner 5
	n (%)	n (%)	n (%)	n (%)	n (%)
Agree	25 (83.3)	18 (60.0)	17 (56.7)	18 (60.0)	19 (63.3)
Disagree	5 (16.7)	12 (40.0)	13 (43.3)	12 (40.0)	11 (36.7)
Total	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)

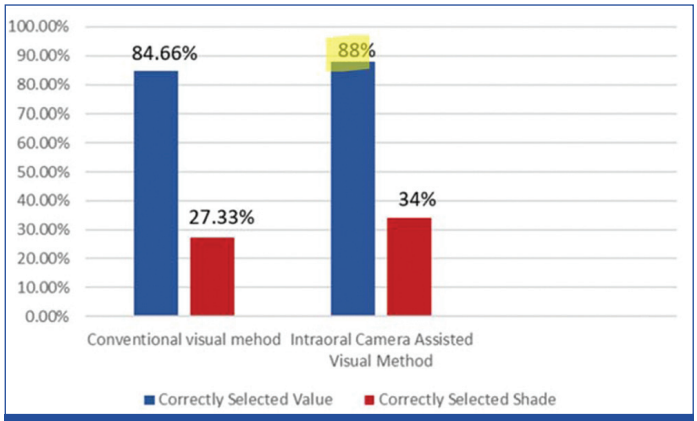
[Table/Fig-7]: Reliability among the examiners with intraoral camera assisted visual method.
Chi-square value=6.011; p-value=0.198 Not significant
Statistical Analysis: Chi-square test

Method	Correct shade selected n (%)	Incorrect shade selected n (%)	Total n (%)	Chi-square value	p-value
Post-insertion shade selection by conventional visual method	41 (27.3)	109 (72.7)	150 (100.0)	1.568	0.211 NS
Post-insertion shade selection with Camera assisted visual method	51 (34.0)	99 (66.0)	150 (100.0)		

[Table/Fig-8]: Comparison of accuracy between shade matching methods. Statistical Analysis: Chi-square test. NS: Not Significant.

assisted visual shade selection, between two shade selection methods results showed no statistically significance.

The comparison of success rate for correctly selected shade and value of those selected shade by two methods i.e., conventional shade selection and intraoral camera assisted selection method are depicted in [Table/Fig-9]. For conventional method, the overall success rate of selected shade was 27.33%, while the success rate was increased to 84.66% for the value. In case of intraoral camera, when the value component of those shades was considered, the success rate increased from 34% to 88%.



[Table/Fig-9]: Accuracy of choosing correct value component from 3D-master shade tab vs accuracy of choosing correct shade from 3D-master shade guide. 3D-master shade guide has code representing value (1-5), hue (L,M,R) and chroma (1-3); it was found that examiner were more accurate when only the value component is considered than the overall shade.

The intra-rater reliability of individual raters is represented as [Table/Fig-10]. To evaluate intra-rater reliability, comparison was made between selected shade (by conventional visual shade matching technique) after cementation of metal ceramic restoration and seven-day post-insertion by individual. Cohen's Kappa has been measured for internal reliability.

Methods	Post-insertion shade selection by conventional visual method immediate vs after 7 days			
Examiners	Agreement	Percentage agreement	Cohen's Kappa	Strength of agreement
Examiner 1	7/30	23.33%	0.182	Slight agreement
Examiner 2	9/30	30.00%	0.253	Fair agreement
Examiner 3	8/30	26.67%	0.218	Fair agreement
Examiner 4	9/30	30.00%	0.253	Fair agreement
Examiner 5	9/30	30.00%	0.253	Fair agreement

[Table/Fig-10]: Intra-rater reliability.

DISCUSSION

One of the complicated aspects of prosthetic dentistry is finding a shade of restoration that perfectly match with adjacent tooth to provide a natural aesthetic look. The two main methods for shade matching are the conventional visual method and the instrumental method using colour measuring devices [5]. Among those methods, the most popular and traditional method of shade selection in dentistry is the visual comparison with a prefabricated shade guide [6]. Though it is the most popular method of shade selection; it is considered as inconsistent and subjective [7]. Human colour assessments are a summation of physiological and psychological responses to a colour stimulus. The perception of colour by an observer is subjective, resulting in varied and unpredictable differences in colour evaluation and matching among clinicians. Except for observer's colour perception, the visual method also depends on factors such as tooth texture contour, translucency, lighting conditions, the surroundings, background. In attempt to overcome the subjectivity inherent in the shade matching process, many studies have been conducted over the years [5,8,9].

In the present study, shades were selected by the two approaches - conventional visual method and intraoral camera assisted visual method. For a single restoration total 10 shades were selected by five examiners in which five shades were by conventional visual method and five shades with intraoral camera; thus, for 30 patient total 300 shades were selected among which 150 was by conventional visual method and 150 with intraoral camera. For conventional visual method 54 shades were aligned with selected final shades among 150 shades, whereas for intraoral camera 97 shades among 150 shades were aligned with final shades [Table/Fig-5]. The difference in two methods was found significant ($p < 0.05$) rejecting the null hypothesis. This signifies that agreement level among the examiners is higher when visual shade selection is done with intraoral camera. So, it proved to be a helpful tool for the examiners in decision making.

A study by Lasserre JF et al., in 2011 stated that SOPRO Shade concept of the SOPRO 717 intraoral camera was a reliable assistance to visual colour assessment compared with conventional visual methods [1]. Igiel C et al., in 2017 evaluated the intra-rater and inter-rater reliability of visual and instrumental shade matching and concluded that significantly higher reliability of instrumental method compared to visual shade selection [10]. The present study yielded comparable findings. The inter-rater reliability of five examiners or raters for visual shade selection showed significant difference [Table/Fig-6] which indicates less agreement level among examiners and higher differences in their choices regarding the shades. Whereas for intraoral camera, inter rater reliability among the examiners showed non significant difference [Table/Fig-7] indicating more agreement in their choices. So, the variability and inconsistency regarding the shade selection was less with intraoral camera assisted visual shade selection.

In visual shade selection, different success rates are found in literature. A study by Okubo SR et al., demonstrated the ability of a computerised colourimeter and a simple visual test to match ceramic shade guide teeth had no statistically significant differences. The Colourtron II instrument correctly matched 50% whereas visual matching by examiners was 48% correct [7]. The present study, confirms these findings. When post fabrication subjective comparison of selected shade and actual shade of the restored tooth were done, it was found that statistically non significant difference between two methods; though the success rate of intraoral camera was higher i.e., 34% than conventional visual method (27.33%).

Intra-rater reliability for visual conventional shade selection method, strength of agreement is fair for examiner 2, 3, 4 and 5; and for examiner 1, it is slight. The reason for such result is either due to internal inconsistency of examiners or due to the method i.e., conventional visual shade selection procedure. As the strength of agreement for all the examiners are very low, the inconsistency of conventional visual shade selection method as the reason; only on value, the reliability scores are significantly higher than general shade can be considered.

In the present study, VITA System 3D-Master® shade guide has been used which is a value based shade guide with code represents value (1-5), hue (L,M,R) and chroma (1-3). It was found from the tabulated chart of selected shade that all the raters were able to choose the value component of particular shades more accurately than overall shade. For conventional method, the overall success rate of selected shade was 27.33%, while the success rate was increased to 84.66% for the value. In case of intraoral camera, when the value component of those shades was considered, the success rate increased to 88% from 34% [Table/Fig-9]. When ignoring hue and chroma and focusing only on value, the reliability scores are significantly higher than general shade matching. This is expected as value (brightness) is the most critical and easiest dimension of colour for the human eye to distinguish. Literature shows that human eye is more sensitive to value because the rod cells in the eyes are very sensitive to lightness/darkness, even with small amounts of light; whereas the cones only become activated with higher light levels and when the cone cells are functioning, the perception of hue and chroma can be changed with change in light levels [11]. Paravina RD et al., examined commercial dental shade guides and mathematically proved that- the influence of lightness difference on total colour difference was the most significant, followed by the influence of saturation and hue difference [12].

Results of the current study indicates that despite following the protocols, success rate of visual shade selection is limited due to its subjectivity and interrelated complex phenomena of influencing factors. Using intraoral camera as an assistance to visual shade selection, only up to a certain level of success rate can be increased by eliminating some environmental influences. Though dentists show inaccuracy, inconsistency in selecting shades by visual methods, but they can efficiently select clinically acceptable shades; which may be the reason of visual method being the most frequently used shade selection method since years and till now. Current research focuses on improving instrumental shade matching and creating advanced computerised techniques to enhance accuracy in producing results [13,14]. Alvarado-Lorenzo A et al., compared two measurement methods used in the field of dentistry: dental guides and spectrophotometry and concluded that the spectrophotometer is more reliable and reproducible [15]. Perou C et al highlighted the importance of incorporating technology as a validation tool like spectrophotometers for enhancing shade-matching accuracy in dental practice [16]. Lee JH and Kim HK showed that intraoral scanner can be used for effective shade matching; they also emphasised on visual confirmation for the best clinical results [17]. In order to achieve aesthetically pleasing and precise outcomes, it is important to strictly adhere to recommended protocols for both conventional and instrumental shade matching. Visual shade selection should be combined with instrumental methods whenever feasible, as this combination can lead to a more pleasing aesthetic result.

Recent literatures mostly concentrate on developing new computerised and digital shade matching devices for more accuracy like colourimeter, intraoral scanner, spectrophotometer; the current study has not included those instrumental methods.

Limitation(s)

In the present study, 24-60 years of age group has been included; it has been found that with ageing, teeth become darker and more yellow. Colour change and discolouration of older teeth represent an additional challenge during shade matching as the shade guides do not cover the entire colour spectrum of their dentition. In such cases, shade guide range is inadequate and lacks a systematic colour.

CONCLUSION(S)

Reliability among five raters or examiners shows statistically significant difference when conventional visual method was used which indicates that agreement level among examiners is less; whereas agreement level is higher for intraoral camera and the shades selected with intraoral camera are more aligned with the shades selected by consensus. Thus, intraoral camera is a helpful tool for the examiners in decision making. When intra-rater reliability was considered by Cohen's Kappa that strength of agreement was not good in any of the examiners indicating the inconsistency of conventional visual shade selection method. So, the intraoral camera can reduce certain level of subjectivity and help the observer for easy decision making by increasing the agreement level, but the overall success rate of visual shade selection cannot be significantly improved with intraoral camera due to the fact that visual shade matching is a procedure which involves inherent subjectivity and complex phenomena which are inevitable.

REFERENCES

[1] Lasserre JF, Pop-Ciutrila IS, Colosi HA. A comparison between a new visual method of colourmatching by intraoral camera and conventional visual and spectrometric methods. Journal of Dentistry. 2011;39: 29-36.

[2] Sirintawat N, Leelaratrungruang T, Poovarodom P, Kiattavorncharoen S, Amornsettachai P. The accuracy and reliability of tooth shade selection using different instrumental techniques: An in vitro study. Sensors. 2021;21(22):7490-98.

[3] Paravina RD, Powers JM. Estheticcolour training in dentistry, Elsevier Mosby. 2004.

[4] Roy S, Raj D, Giri TK, Mukherjee S. A comparative study on the visual shade matching performance of dental students. Int J Prosthodont Restor Dent. 2022;12(1):25-29.

[5] Shapiro JR, Resk RE. Colour management. Current Opinion in Cosmetic Dentistry. 1994;13:9-145.

[6] Bayindir F, Kuo S, Johnston WM, Wee AG. Coverage error of three conceptually different shade guide systems to vital unrestored dentition. The Journal of Prosthetic Dentistry. 2007;98(3):175-85.

[7] Okubo SR, Kanawati A, Richards MW, Childressd S. Evaluation of visual and instrument shade matching. The Journal of Prosthetic Dentistry. 1998;80(6):642-48.

[8] Hammad IA. Intrarater repeatability of shade selections with two shade guides. The Journal of Prosthetic Dentistry. 2003;89(1):50-53.

[9] Van der Burgt TP, Ten Bosch JJ, Borsboom PC, Kortsmit WJ. A comparison of new and conventional methods for quantification of tooth colour. The Journal of Prosthetic Dentistry. 1990;63(2):155-62.

[10] Igiel C, Lehmann KM, Ghinea R, Weyhrauch M, Hangx Y, Scheller H, et al. Reliability of visual and instrumental colour matching. Journal of Esthetic and Restorative Dentistry. 2017;29(5):303-08.

[11] Fondriest J. Shade matching in restorative dentistry: The science and strategies. International Journal of Periodontics and Restorative Dentistry. 2003;23(5):467-80.

[12] Paravina RD, Powers JM, FAY RM. Dental colour standards: Shade tab arrangement. Journal of Esthetic and Restorative Dentistry. 2001;13(4):254-63.

[13] Borse S, Chaware SH. Tooth shade analysis and selection in prosthodontics: A systematic review and meta-analysis. J Indian Prosthodont Soc. 2020;20(2):131-40. Doi: 10.4103/jips.jips_399_19. Epub 2020 Apr 7. PMID: 32655217; PMCID: PMC7335029.

[14] Jouhar R, Ahmed MA, Khurshid Z. An overview of shade selection in clinical dentistry. Applied Sciences. 2022;12(14):6841.

[15] Alvarado-Lorenzo A, Criado-Pérez L, Cano-Rosás M, Lozano-García E, López-Palafox J, Alvarado-Lorenzo M. Clinical comparative study of shade measurement using two methods: Dental guides and spectrophotometry. Biomedicines. 2024;12(4):825. Doi: 10.3390/biomedicines12040825. PMID: 38672180; PMCID: PMC11048452.

[16] Perou C, Petalas A, Stoupi M, Hadjichristou C. Effectiveness of lighting conditions on shade matching accuracy among dental students. Dent J (Basel). 2025;13(3):130. Doi: 10.3390/dj13030130. PMID: 40136758; PMCID: PMC11941076.

[17] Lee JH, Kim HK. A comparative study of shade-matching performance using intraoral scanner, spectrophotometer, and visual assessment. Sci Rep. 2024;14(1):23640. Doi: 10.1038/s41598-024-74354-z. PMID: 39384854; PMCID: PMC11479611.

PARTICULARS OF CONTRIBUTORS:
1. Senior Lecturer, Department of Prosthodontics and Crown and Bridge, Kusum Devi Sunderlal Dugar Jain Dental College and Hospital, Kolkata, West Bengal, India.
2. Professor, Department of Prosthodontics and Crown and Bridge, Guru Nanak Institute of Dental Sciences and Research, Kolkata, West Bengal, India.
3. Principal, Professor and Head, Department of Prosthodontics and Crown and Bridge, Guru Nanak Institute of Dental Sciences and Research, Kolkata, West Bengal, India.
4. Reader, Department of Prosthodontics and Crown and Bridge, Guru Nanak Institute of Dental Sciences and Research, Kolkata, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Sunetri Mondal,
DL-136, Sector 2, Salt Lake City, North 24 Paraganas,
Kolkata-700091, West Bengal, India.
E-mail: sunetri967@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 23, 2025
- Manual Googling: Jan 17, 2026
- iThenticate Software: Jan 20, 2026 (4%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jul 04, 2025**
Date of Peer Review: **Sep 26, 2025**
Date of Acceptance: **Jan 23, 2026**
Date of Publishing: **May 01, 2026**