

Dr. Bhavika Khated, Dr. Namrata Shah Naidu, Dr. Rajesh Sethuraman, Dr. Modem Jayachandra,

ABSTRACT

BACKGROUND: Tooth shade selection is a complicated task fundamentally affecting esthetic outcomes of restorative treatments. Since color matching is considered a subjective procedure, accurate shade choice is often the most challenging stage of recreating the natural appearance of teeth. Furthermore, accurate determination of tooth color is imperative for the final outcome of dental restorations. The purpose of this research is to evaluate and compare the accuracy of Shade selection using VITA Classical, VITA 3D Master shade guide, Intraoral scanner with Clinical Spectrophotometer.

METHODOLOGY: Shade of central incisors of 36 participants were obtained by Intraoral scanner, Visual method (VITA CLASSICAL and 3D Master guide) individually and compared to that of the Spectrophotometer. All the reading of shade selection were obtained under similar light conditions.

RESULTS: Results were subjected to Non-Parametric Spearman's Rank Correlation Coefficient Test. 3D master shade guide shows strong co-relation with intraoral scanner and spectrophotometer as compared to Vita classical which shows weak co-relation

CONCLUSION: Accuracy of clinical Spectrophotometer were closer to VITA 3D Master shade guide as compared to intraoral scanner and VITA Classical shade guide.

KEYWORDS: Color; Digital dentistry; Shade selection; Shade guide; Intraoral scanner

INTRODUCTION:

The esthetic concern of the patient is one of the major concerns and most challenging factors for dental practitioners.¹ A proper treatment plan, treatment technique, and communication are essential to alleviate this concern. The determination of tooth shade is a critical feature of aesthetic dental restoration, particularly in the anterior zone.²

Colour matching technologies have recently been developed to improve the accuracy of aesthetic restoration. The current clinical methods of determining tooth color in dentistry include visual and instrumental methods.³

The increasing aesthetic needs of patients in dentistry necessitate higher expertise in tooth shade determination. Furthermore, selecting the appropriate shade of teeth is frequently the most difficult step in replicating their natural appearance.⁴ In fact, researchers have considered

color matching as a subjective procedure, reliant on several influences, such as light source, object, and observer.⁵ Yet, in dental shade matching, the human eye is still the most popular clinical approach. Colour normal vision allows a person to retain around 300 different colours and differentiate 5-10 million different colours in side-by-side comparisons.⁶

Even so, studies have reported that up to 80% of the patients express their dissatisfaction with shade differences.⁷ It has been stated that in dental shade matching, the eye is the finest null detector, nonetheless, observers must be trained to optimize their color perception. The matching of color shades is generally associated with homogeneously colored objects, while the color and transparency of teeth vary considerably. Color communication using shade guides is the most shared technique. Nevertheless, this method is subjective, as it is affected by factors like age, sex,

* PG Student, **Professor & Head

No 9 Department of Prosthodontics, K M Shah Dental College

and Hospital, Sumandeep Vidyapeeth Deemed to be University, Piparia, Vadodara 391760

ADDRESS FOR AUTHOR CORROSPONDENCE : Dr. Bhavika Khated , E-mail : bhavikakhated@gmail.com,Ph.: +91 9423369780

observer experience, eye fatigue, and ambient light.⁶

In this regard, instrumental techniques have grown in popularity, but they are costly and not always accessible to dentists.⁸ Instrumental methods include spectrophotometers, intraoral scanners, digital cameras, and smart phones, among others.⁹ These devices consist of a detector, signal conditioner, and software that process the signal to make the data usable in a clinic or laboratory.¹⁰ Spectrophotometric color measurements are capable of reliably quantifying the color of both extracted teeth and dental materials.¹¹

Previous studies have reported the use of spectrophotometers as a reference in color matching studies because they demonstrate greater reliability than visual shade matching methods.¹² The accuracy of the Vita Easyshade Advance 4.0 was estimated to be 92.6% and its repeatability, 96.4%.¹³

Furthermore, new generations of digital intraoral scanning instruments with built-in shade evaluation functions have emerged. The accuracy of Vita 3D-Master shade guidance, 3Shape Trios intraoral scanner, and Vita Easyshade was assessed in a study of 107 patients. The accuracy of the 3Shape Trios 3 intraoral scanner was 43.9%.¹² In this study, they used vita easy shade with repeatability of 76.6% while using Vita Easyshade. However, when using 3Shape Trios 3, it was 78.3%. Therefore, Brandt et al. found that Trios 3 is a good option for tooth shade selection.¹⁴ Rutkunas et al¹⁵ found the accuracy of the Trios intraoral digital scanner to be 53.3% when the 3D-Master values were used.

Studies have shown different results regarding the

correlation between spectrophotometers and intraoral scanners.^{16,17}

This in vivo study aimed to compare and evaluate accuracy of shade selection with clinical spectrophotometer, intraoral scanner with visual method using VITA Classical and VITA 3D Master shade guides.

Therefore, the purpose of the present study is to compare the accuracy of color matching between different shade selection methods. The null hypothesis tested was that all different shade selection methods would have the same accuracy.

METHODOLOGY:

A total of 36 participant were selected for the study with age of 20-40 yrs. Teeth with any discoloration, developmental disorder, teeth with crown and veneers were excluded from the study. The only inclusion criteria were the presence of an unrestored and unstained natural tooth. Patient consent was procured, and those not willing to be a part of the study were not included. Shade selection was done three different methods spectrophotometric method, intraoral scanner with visual method using vita classical and vita 3D master shade guides. The lead investigator used the pseudochromatic colour plate test developed by Farnsworth and the Munsell colour test to minimise any discrepancy in shade selection. In between every test to avoid the color fatigue, the lead investigator deprogrammed his vision by looking at a blue sheet for 5 second as suggested by Veerganta et al.¹⁸ All the shade matching procedures were performed on the same dental chair between 10 am to 12 pm on a clear sunny day.

GROUP-1 VISUAL METHOD

The teeth were cleaned to ensure increased accuracy in shade determination. If the patient

Khated Et. At. Comparative evaluation of accuracy of shade selected using VITA Classical, VITA 3D Master shade guides, intraoral scanner with clinical spectrophotometer

arrived wearing the lipstick, it was removed before tooth shade determination. Visual method was performed using shade matching light which emits day light 5500°kelvin was chosen. The subject was viewed at eye level by placing shade tab next to selected tooth. The shade tab device was held around 30 cm from the eyes and the colour was selected as rapidly as possible. The surfaces of the teeth were kept moist to avoid drying. The right

central incisor's middle third was chosen for evaluation of shade in all individuals. Based on the corresponding shade tab, suitable shade was noted.

Tooth shade was determined in one step with Vita classical and two steps with vita 3D master. In the case of vita 3D master, the value was first selected, and in the second step, chroma and hue selection were performed simultaneously.

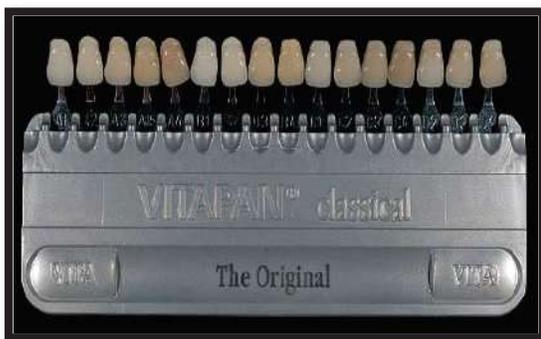


Figure : 1.a : Group A-Visual method using Vita classical shade guide



Figure : 1.b : Group A-Visual method using Vita 3D master shade guide

GROUP-2 INTRAORALSCANNER

Shade selection was carried out using the 3Shape TRIOS 3 basic intraoral scanner (3Shape®, Copenhagen, Denmark). After scanning the model and calibrating the shade in accordance with the manufacturer's instructions, the examiner selected the shade feature and placed the shade measuring circle in the desired location to automatically

generate the shade assessment. The circle was positioned on the buccal side per the manufacturer's instructions, and we avoided placing it in the interproximal or transparent area to get the most accurate data. In this study, however, the circle was put on the measurement point, which was located in the centre third of the tooth.



Figure 2 : Group B- Shade selection using TRIOS Intraoral scanner

GROUP -3 SPECTROPHOTOMETER METHOD

The spectrophotometer used in this study was the VITA Easyshade Advance 5.0. (VITA Easyshade Advance 5.0, VITA Zahnfabrik, Bad Sackingen, Germany). Patient was made to sit on chair. Tooth to be measured was observed carefully, color

gradient of the tooth was noted. Once mode of measurement of color chosen, probe tip was kept 0-0.5mm away from tooth. Probe tip was held against the tooth, “start” button was pressed, after hearing short beep result was displayed on the screen and were noted.



Figure 3 : Group C- Shade selection using Spectrophotometric Method

Statistical analysis was subjected to Non-Parametric Spearman's Rank Correlation Coefficient Test

RESULTS:

In order to facilitate the statistical analysis, a numerical value was assigned for each shade tab

codification. Thus, The Vita Classical Shade tab and the Vita 3D Master Shade tab were arranged on a value scale basis.

Table 1. Vita Classical Shade tab arrangement and codification

B1	A1	B2	D2	A2	C1	C2	D4	A3	D3	B3	A3.5	B4	C3	A4	C4
21	11	22	42	12	31	32	44	13	43	23	13.5	24	33	14	34

Table 2 : Vita 3D Master Shade tab numerical codification

Khated Et. At. Comparative evaluation of accuracy of shade selected using VITA Classical, VITA 3D Master shade guides, intraoral scanner with clinical spectrophotometer

0M1			2M1			3M1			4M1		5M1
0M2	1M1	2L1.5	2M2	2R1.5	3L1.5	3M2	2R1.5	4L1.5	4M2	4R1.5	5M2
0M3	1M2	2L2.5	2M3	2R2.5	3L2.5	3M3	2R2.5	4L2.5	4M3	4R2.5	5M3
071			271			371			471		571
072	171	261.5	272	281.5	361.5	372	2R1.5	461.5	472	481.5	572
073	172	262.5	273	282.5	362.5	373	2R2.5	462.5	473	482.5	573

Table 3 : Shade selection done according to Vita Classical Shade guide system

NO	Group A VITA Classical	Group B Intraoral scanner	Group C Clinical spectrophotometer
1	11	11	11
2	11	11	11
3	22	22	22
4	22	22	11
5	22	22	11
6	22	22	22
7	11	11	11
8	11	11	11
9	11	11	11
10	11	11	11
11	11	11	11
12	11	11	13
13	11	11	11
14	13	13	12
15	14	14	13
16	12	12	21
17	14	13	11
18	13.5	13.5	12
19	42	42	21
20	43	43	11
21	43	43	13
22	42	42	21
23	43	43	11
24	13.5	13.5	13
25	22	22	11
26	23	23	12
27	24	24	23
28	11	11	11
29	12	12	12
30	33	33	33
31	11	11	11
32	22	22	22
33	13	13	13
34	21	21	21
35	22	22	22
36	13	13	13

Table 4 : Shade selection done according to Vita 3D Master Shade guide system

NO	Group A VITA 3D master	Group B Intraoral scanner	Group C Clinical spectrophotometer
1	171	171	171
2	171	171	381.5
3	272	272	381.5
4	272	171	171
5	272	171	271
6	272	272	272
7	171	171	171
8	171	171	171
9	171	171	271
10	171	171	171
11	171	171	171
12	171	372	271
13	171	171	272
14	372	381.5	272
15	481.5	372	572
16	381.5	271	271
17	372	171	571
18	382.5	381.5	572
19	371	271	271
20	472	171	572
21	473	372	572
22	371	271	272
23	473	171	373
24	382.5	372	462.5
25	272	171	272
26	373	381.5	373
27	462.5	373	462.5
28	171	171	272
29	381.5	381.5	373
30	461.5	481.5	462.5
31	171	372	272
32	272	272	373
33	372	372	462.5
34	271	271	272
35	272	272	373
36	372	372	462.5

Table 5 : Sperman’s Rank Correlation Coefficient Test

	Vita classical	Vita 3D master	Intraoral scanner
Spectrophotometer	0.473	0.731	0.488
p Value	0.003	0.001	0.002
Inference	Moderate corelation	Strong corelation	Moderate corelation

DISCUSSION:

Esthetic dentistry is emerging as one of the challenging branches of this field. Shade matching of maxillary anterior is one of the tough clinical challenges faced in dentistry.¹⁰ However, spectrophotometer method of shade evaluation is considered as gold standard¹⁹ for measuring tooth color and to provide high level of agreement for the usage of shade selection in dentistry.⁸

In the attainment of a perfect tooth color, shade matching was a key factor in esthetic restorations.²⁰ Furthermore, color mismatch in ceramic restorations can be very stressful for both clinicians and patients. In order to achieve a good match between tooth colors, a combination of visual and digital techniques has been suggested.¹¹ Visual technique consists of comparing shade guides with natural teeth to find the closest match.⁸ It is subjective, and its accuracy is determined by factors such as experience, sex, and the spectator's training, as well as the tooth shade and light source.²¹

The computerised photographs gave the dentists and dental technicians the crucial details they need for the creation of prosthetics, including the colour, shape, and surface features of the teeth when seen across. Additionally, this would enhance communication and colour choice. Whenever feasible, both techniques should be combined.¹¹ Although the Vita Classical shade guide is the most widely used system in dental practise, 3D-Master shade tabs, a system founded on scientific mathematical theory, was chosen as the instrument most often producing the best shade for the examined teeth, followed by the digital methods spectrophotometer and then Trios intraoral scanner⁴ which was in accordance to the

present study.

On comparing spectrophotometric method with the visual method it was found Spectrophotometer showed better results in comparison with the visual method which was in accordance with Paul et al.²² where he explained that spectrophotometer accuracy 33% more than the human eye, and it increases up to 93.3% in a close match to the tooth. Chen et al. carried out a comprehensive study of the literature in 2012 to compare the accuracy and precision of the subjective and objective colour choosing methods. The most accurate and exact performance came from the objective method.²³ In comparison to the subjective technique that uses shade tabs, Vita EasyShade Advance delivers more accurate results in picking colour, according to a study by Igiel et al. in 2017²⁴. Therefore, the spectrophotometer has been used as the gold standard for shade matching in this investigation. The Vita Easy Shade (VES) spectrophotometer's ability to lessen the subjective mistake of the visual shade approach is by far its greatest benefit.²⁵

Öngül D et al²⁶ and Paravina RD et al²⁷ studies compared Vita 3D master and Vita Classical shade guide and showed that 3D-Master shades provide more reliable choices for tooth color. The Vitapan 3D-master shade guide system produced better shade-matching results and a more consistent colour difference (E = 5) than other shade guides in the visual shade guide which was in accordance to present study.

In the present study instrumental shade matching by spectrophotometer was used to compared with Vita Classical, Vita 3D master and intraoral scanner. In which Vita 3D master shows strong correlation with spectrophotometer while Vita

Khated Et. At. Comparative evaluation of accuracy of shade selected using VITA Classical, VITA 3D Master shade guides, intraoral scanner with clinical spectrophotometer

classical and Intraoral scanner shows moderate level of correlation with spectrophotometer. According to Siddhesh Borse et al²⁵ in 2020 reported a significant color difference between the instrumental method and visual method of tooth shade selection. VES spectrophotometer demonstrated significant color difference than other devices used for tooth color selection, and Vita 3D master showed highly significant values for color difference than the Vita classical and other shade guides from different manufacturers.

The 3D master shade guide offers higher colour matching than previous shade tabs, more ordered colour dispersion, and superior traditional shade matching. The unbalanced distribution of colour space that is pertinent to human teeth was reported by the Vita classical shade tabs.²⁵ Due to this reason in the present study Vita Classical shows weak correlation as compared to Vita 3D master shade guide compared to spectrophotometer.

Limitation of this in vivo study is larger sample size with different age groups need to be evaluated. Only one type of intraoral scanner and spectrophotometers is used in the present study. So different types scanner and spectrophotometers can be used to compare and evaluated together.

CONCLUSION:

Within the limitation of present study, Accuracy of clinical Spectrophotometer were closer to VITA 3D Master shade guide as compared to intraoral scanner and VITA Classical shade guide. The TRIOS intraoral scanner can be used as an alternative method of shade selection with a 3D-Master tooth color system, but it is recommended to verify the measurement with visual methods.

REFERENCES:

1.Rokaya D, Kitisubkanchana J, Wonglamsam A,

Santiwong P, Srithavaj T, Humagain M. Nepalese esthetic dental (NED) proportion in Nepalese population. Kathmandu University Medical Journal. 2015;13(3):244-9.

2.Siddique SN, Khan FR, Babar P. Comparison of tooth shade matching using visual and digital camera methods. Pakistan Oral & Dental Journal. 2019 Jul 28;39(2):184-8.

3.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 Nov 11;21(22):7490.

4.Czigola A, Roth I, Vitai V, Fehér D, Hermann P, Borbély J. Comparing the effectiveness of shade measurement by intraoral scanner, digital spectrophotometer, and visual shade assessment. Journal of Esthetic and Restorative Dentistry. 2021 Dec;33(8):1166-74.

5.Takatsui F, Andrade MF, Neisser MP, Barros LA, Loffredo LD. CIE L* a* b*: comparison of digital images obtained photographically by manual and automatic modes. Brazilian oral research. 2012;26:578-83.

6.Della Bona A, Barrett AA, Rosa V, Pinzetta C. Visual and instrumental agreement in dental shade selection: three distinct observer populations and shade matching protocols. dental materials. 2009 Feb 1;25(2):276-81.

7.Kawaragi C, Ishikawa S, Miyoshi F, Furukawa K, Ishibashi K. Evaluations by dentists and patients concerning the color of porcelain fused-to-metal restorations. Dent J Iwate Med Univ. 1990;15(9).

8.Suganya SP, Manimaran P, Saisadan D, Kumar CD, Abirami D, Monnica V. Spectrophotometric evaluation of shade selection with digital and

Khated Et. At. Comparative evaluation of accuracy of shade selected using VITA Classical, VITA 3D Master shade guides, intraoral scanner with clinical spectrophotometer

- visual methods. *Journal of Pharmacy & Bioallied Sciences*. 2020 Aug;12(Suppl 1):S319.
- 9.Tabatabaian F, Beyabanaki E, Alirezaei P, Epakchi S. Visual and digital tooth shade selection methods, related effective factors and conditions, and their accuracy and precision: A literature review. *Journal of Esthetic and Restorative Dentistry*. 2021 Dec;33(8):1084-104.
- 10.Brewer JD, Wee A, Seghi R. Advances in color matching. *Dental Clinics*. 2004 Apr 1;48(2):341-358.
- 11.Hardan L, Bourgi R, Cuevas-Suárez CE, Lukomska-Szymanska M, Monjarás-Ávila AJ, Zarow M, Jakubowicz N, Jorquera G, Ashi T, Mancino D, Kharouf N. Novel trends in dental color match using different shade selection methods: a systematic review and meta-analysis. *Materials*. 2022 Jan 8;15(2):468.
- 12.Czigola A, Roth I, Vitai V, Fehér D, Hermann P, Borbély J. Comparing the effectiveness of shade measurement by intraoral scanner, digital spectrophotometer, and visual shade assessment. *Journal of Esthetic and Restorative Dentistry*. 2021 Dec;33(8):1166-74.
- 13.Kim-Pusateri S, Brewer JD, Davis EL, Wee AG. Reliability and accuracy of four dental shade-matching devices. *The Journal of prosthetic dentistry*. 2009 Mar 1;101(3):193-9.
- 14.Brandt J, Nelson S, Lauer HC, von Hehn U, Brandt S. In vivo study for tooth colour determination—visual versus digital. *Clinical oral investigations*. 2017 Dec;21:2863-71.
- 15.Rutkūnas V, Dirsė J, Bilius V. Accuracy of an intraoral digital scanner in tooth color determination. *The Journal of prosthetic dentistry*. 2020 Feb 1;123(2):322-9.
- 16.Culic C, Varvara M, Tatar G, et al. In vivo evaluation of teeth shade match capabilities of a dental intraoral scanner. *Curr Health Sci J*. 2018;44:337-341.
- 17.Yilmaz B, Irmak Ö. Outcomes of visual tooth shade selection performed by operators with different experience. *J Esthet Restor Dent*. 2019;31:500-507.
- 18.Miyajiwala JS, Kheur MG, Patankar AH, Lakha TA. Comparison of photographic and conventional methods for tooth shade selection: A clinical evaluation. *The Journal of the Indian Prosthodontic Society*. 2017 Jul;17(3):273.
- 19.Dozić A, Kleverlaan CJ, El-Zohairy A, Feilzer AJ, Khashayar G. Performance of five commercially available tooth color-measuring devices. *Journal of Prosthodontics*. 2007 Mar;16(2):93-100.
- 20.Alghazali N, Burnside G, Moallem M, Smith P, Preston A, Jarad FD. Assessment of perceptibility and acceptability of color difference of denture teeth. *Journal of dentistry*. 2012 Jul 1;40:e10-7.
- 21.Clary JA, Ontiveros JC, Cron SG, Paravina RD. Influence of light source, polarization, education, and training on shade matching quality. *The Journal of prosthetic dentistry*. 2016 Jul 1;116(1):91-7.
- 22.Paul S, Peter A, Pietrobon N, Hämmerle CH. Visual and spectrophotometric shade analysis of human teeth. *Journal of dental research*. 2002 Aug;81(8):578-82.
- 23.Chen H, Huang J, Dong X, Qian J, He J, Qu X, Lu E. A systematic review of visual and instrumental measurements for tooth shade matching. *Quintessence International*. 2012 Sep 1;43(8).
- 24.Igiel C, Lehmann KM, Ghinea R, Weyhrauch M, Hangx Y, Scheller H, Paravina RD. Reliability

Khated Et. At. Comparative evaluation of accuracy of shade selected using VITA Classical, VITA 3D Master shade guides, intraoral scanner with clinical spectrophotometer

of visual and instrumental color matching. *Journal of Esthetic and Restorative Dentistry*. 2017 Sep;29(5):303-8.

25. Borse S, Chaware SH. Tooth shade analysis and selection in prosthodontics: A systematic review and meta-analysis. *The Journal of the Indian Prosthodontic Society*. 2020 Apr;20(2):131.

26. Öngül D, Sermet B, Balkaya MC. Visual and instrumental evaluation of color match ability of 2

shade guides on a ceramic system. *J Prosthet Dent*. 2012;108:9-14.

27. Paravina RD. Performance assessment of dental shade guides. *Journal of dentistry*. 2009 Jan 1;37:e15-20.

Rutkūnas V, Dirsė J, Bilius V. Accuracy of an intraoral digital scanner in tooth color determination. *The Journal of prosthetic dentistry*. 2020 Feb 1;123(2):322-9.