COMPARATIVE EVALUATION OF SHADE MATCH BETWEEN SINGLE SHADE AND UNIVERSAL SHADE RESTORATIVE COMPOSITE: AN IN VITRO STUDY.

DISSERTATION

Submitted to

BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH

In the partial fulfilment of the requirement for the degree

Of

MASTER OF DENTAL SURGERY

In the subject of

CONSERVATIVE DENTISTRY & ENDODONTICS

Submitted by

DR. ANUJA KAUSHIK

Under the guidance of

DR. (Prof.) PRAVEEN SINGH SAMANT

DEPARTMENT OF CONSERVATIVE DENTISTRY & ENDODONTICS

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW

Batch: 2021-24 Enrolment No.: 12103222927

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"Comparative Evaluation Of Shade Match Between Single Shade And Universal Shade Restorative Composite: An In Vitro Study"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. Praveen Singh Samant**, Professor & Head, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

Date: 19. Feb. 2024

Signature of the Candidate

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CERTIFICATE BY THE GUIDE/CO-GUIDE

This is to certify that the dissertation entitled **"Comparative Evaluation Of Shade Match Between Single Shade And Universal Shade Restorative Composite: An In Vitro Study"** is a bonafide work done by **Dr. Anuja Kaushik**, under our direct supervision & guidance in partial fulfilment of the requirement for the degree of **Master of Dental Surgery (M.D.S.)** in the specialty of Conservative Dentistry and Endodontics.

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ENDORSEMENT BY THE HOD

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I beg forgiveness from those whose names I have inadvertently missed but they should find solace that their knowledge has been extended to others by way of this thesis.

DR. ANUJA KAUSHIK

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ABSTRACT

Resin composites are elected as material of choice due to their aesthetic, elective and good mechanical properties, making them suitable for multiple clinical situations. In restorative dentistry the term ‘chameleon effect’ (blending effect) describes the ability of the material to acquire the similar shade to that of the surrounding and adjoining tooth structure. This property has enabled a simplified way of shade selection and reproduction of the similar shades. Recently a concept of ‘universal shade’ has been introduced to aesthetically simulate all shades of the tooth with one nominal shade. These materials are formulated on wide colour matching concept. Which are expected to blend seamlessly with the surrounding dentition regardless of the tooth shade.

Our aim is to evaluate shade by two different observers using different brands of universal shade composite resin, in anterior (class V and class IV restorations) and posterior (class I compound and class V restorations) in extracted teeth, and to confirm the results with those of a digital gadget (spectrophotometer).

A total of 80 teeth were selected for the study to be restored thrice with the chosen materials for the study. These teeth first chosen as experimental group A and were restored with Omnichroma, then chosen as experimental group B and were restored with Charisma Topaz ONE and then chosen as the control group C were restored with Charisma Diamond composite materials. Prior to the restoration base shade was evaluated with both visual and with spectrophotometer. Shade was evaluated after each restoration both visually and with spectrophotometer.

The results were then statistically analysed using unpaired t-tests. The data was statistically analysed using SPSS version 20.

There was a significant difference in the shade match of universal shaded composite material and group shaded composite material; wherein the group shaded composite material performed better significantly both visually and with spectrophotometer.

However, further in vivo studies are required to evaluate further optical properties of universal shaded composite materials like Omnichroma and Charisma Topaz one

INTRODUCTION

INTRODUCTION

For numerous millennia, scientists, academicians, and artists have been fascinated by aesthetics or beauty, and they have endeavoured to understand this mysterious phenomenon. The three primary theories of aesthetics are perceptual (social interaction and persona), psychological (relating to an individual's psychoemotional make-up shaped by academic, cultural, social, economic, and religious status), and geometric (mathematical computations for analysing and creating beauty). Perceptual theories and psychological theories differ primarily in that perception is how other people "see" us, whereas psychology is how we "see" ourselves. The geometric theories, which originated in ancient Egypt approximately 3000 BCE, serve as the cornerstone of dental aesthetics.

Nevertheless, most of these ideas have since been refuted when applied to dentistry, particularly the Golden ratio, which was—and maybe still is—used to justify excessive treatment in the name of producing "perfect smiles." Mathematical ideas are the foundation of smile design and are helpful as a framework, but it should be noted that there is no secret recipe for beauty. All three theories are integrated into a thorough aesthetic treatment plan so that the patient's wants are met rather than the clinician's views or opinions being reinforced.

Colour plays a significant role in daily existence. When you discuss the value of colour with individuals, there is rarely any genuine disagreement. Most individuals concur that colour plays a significant, if not essential, role in life. But the extent to which individuals truly comprehend that fact at a fundamental level is a bigger challenge.

People frequently discuss the value of colour in fairly abstract terms when discussing its significance. It's common knowledge that colour matters. They are unable to adequately convey the significance of colour or the potential consequences of its absence on a person's quality of life, though. It is worthwhile to investigate the significance of colour because of this ambiguity.

In cosmetic dentistry, colour interplay is very important. Knowledge of primary, secondary, and complementary colours is important to manage and adjust hues for a predicted aesthetic restorative effect. For aesthetic dental restorations, colour matching is crucial for several reasons.

Psychological Effect on Patients: Confidence and self-worth can be greatly impacted by how one smiles.

Enhanced patient acceptance and satisfaction: Dental restorations give a smile a sense of balance and harmony when they precisely match the colour of the patient's natural teeth.

Psychophysics is a branch of science that studies the connection between perceptions elicited by physical stimuli and their colour. The dentin's hue and the enamel's thickness, dispersion, and translucency are the primary causes of tooth colour. From gingival to incisal/occlusal, buccal to lingual, and mesial to distal, tooth colour varies in all directions. (1)

There are two types of colour determination in dentistry: visual and instrumental. Whether describing the colour of restorative materials using colorimetry or human observation, there are several issues that come up. The determination of color in human observation is contingent upon various factors, including prior exposure to light, the relative positions of the object and illuminant with respect to the observer, and the color properties of the illuminant. Even when materials are mixed, they become even more complex color-related difficulties, especially when they are introduced into the oral environment. (2,3)

An object's color is determined by the components of incident white light that are reflected. Light can flow through transparent materials with little alteration. Materials that are translucent can transmit, absorb, and disperse light. Materials that are opaque absorb and reflect light but do not transmit it. The majority of a natural tooth's color is innate to the tooth. (4) It can be stated that shade selection shows marked inter-observer variation. (5) For many years, people have used dental shade guides to visually identify and communicate colour. Shade guide tabs, however, might differ even from manufacturer to manufacturer. (6) In their investigations , O'Brien *et al*. (7) and Paravina *et al*. (8) have demonstrated that two shade guidelines from the same manufacturer may differ. It should be the aim of the practitioner to make the dentin and enamel layers of the composite replicate the anatomic thickness of that tooth before restoration in order to attain the desired qualities of natural teeth. [9] Tooth shade guides provide a range of standards that mimic natural teeth. It is up to the dentist to determine which standard provides the closest color match to the tooth or teeth in question and if the patient would be satisfied with the match. The suitability of the shade guide and the dentist's competence with fundamental color-matching techniques are critical factors that determine whether this operation is successful or unsuccessful. [10]

It was discovered by Park *et al.* [11] that the colour distributions of the two distinct shade guides were clinically unacceptable when they were examined under various illuminants. Apart from the fact that current shade guides do not encompass the whole spectrum of dental shades, uncontrollable elements including aging, weariness, lighting, contrast, and metamerism can also lead to discrepancies. [12-14]

Achieving a tight shade match between an artificial restoration and the natural dentition is a complicated operation because of the wider range of tooth colours. To achieve a restoration that looks natural, practitioners need to have a thorough understanding of the colour, light, and related properties of porcelain and resin. They also need to be able to accurately explain directions to the lab technician. [5] Therefore, the primary objective of the study is to determine how group shaded composite resin and single shaded composite resin differed in terms of shade match. In addition to the previously stated, spectrophotometry is used to determine any potential shade discrepancies between the human eye and the digital technique.

The composition, colour availability, transparency levels, and effects of resin composites have all improved recently, and this has helped to some extent with their physical, mechanical, and optical properties. However, because of their inherent material, resin composites still have lower biomimetic potential because they lack a crystalline structure and because many restorative systems have reduced translucency, opacity, effects, and fluorescence. These features by themselves greatly complicate the process of matching the colour of the resin composite to the tooth structure.

Computerized colourimetry or spectrophotometry data enable for a mathematical comparison based on CIE-Lab (1971) characteristics (Commission Internationale de l'Eclairage, L = lightness, a = chroma along red-green axis, b = chroma along yellow-blue axis). [15]

The tooth is brightened and given optical depth and liveliness by the opalescent effects of enamel. Due to the phenomenon known as opalescence, a tooth will appear to be one color when light is reflected from it and a different colour when light passes through it. Anisotropic light properties are correlated with tooth or porcelain opalescence. The variation in visual appearance based on the illumination or viewing angle is known as optical anisotropy. The variation in the incisal halo's width, chroma, and colour based on the illumination angles serves as an illustration of this. [16]

The phrase "chameleon effect" (also known as the "blending effect") in restorative dentistry refers to a material's capacity to take on a hue that is comparable to the surrounding tooth structure. Because of this characteristic, new dental composites that make shade selection and replication easier have been made possible. The so-called "group-shaded" composites, which had a relatively limited shade range and each shade covering a suggested group of VITAPAN classical shades, were one method used initially. [17,18] The term "one shade" or "single shade" composite resins was coined recently to refer to resin-based composites that have been created to aesthetically mimic all shades using just one nominal shade. Regardless of the hue of the teeth, these materials, which were created using the broad colour matching idea, are meant to blend in smoothly with the surrounding dentition. [19]

An object's perceived colour is determined by the wavelengths it reflects. This selective wavelength reflection in aesthetically pleasing materials, such as ceramics and resin-based composites, is caused by pigments that are a part of their composition. Nonetheless, one-shaded resin-based composites have been generated thanks to inventive technological approaches. The manufacturer (Tokuyama Dental) claims that Omnichroma, a one-shade universal resin-based composite, is free of pigments and that structural colour—a "smart chromatic technology"—is the basis for its optical properties. This means that when light waves strike the resin-based composite at a particular frequency, it will precisely reflect a particular wavelength inside the tooth colour space. Furthermore, new research revealed that Omnichroma's primary benefit is dependent on improved Colour Adjustment

Potential. [20] The "adaptive light matching" concept, which is the foundation of another technique utilized to create Kulzer's Charisma Topaz One [21], states that the restoration shade is produced by absorbing the wavelengths reflected by the surrounding tooth shade. [20]

A clinical advantage may result from dental materials that exhibit colour shifting toward the colour of the surrounding hard dental tissues, as this can enhance the restoration's aesthetic appearance, make shade matching easier, require fewer shade guide tabs, and partially offset colour mismatches.

OMNICHROMA and CHARISMA TOPAZ ONE are universal composite with a single shade of structural colour that are intended for use in the majority of direct restorative therapeutic applications. Due to their broad colour matching capability, clinicians can cut chair time, waste fewer composite shades, and depend less on shade-matching methods. It also eliminates the need for a shade-taking procedure and reduces composite inventory. [22] The purpose of the null hypothesis was to determine whether a universal resin composite with a single structural colour would change its shade to match the shade of the tooth structure.

Our aim is to evaluate shade by two different observers using different brands of universal shade composite resin, in anterior (class V and class IV restorations) and posterior (class I compound and class V restorations) in extracted teeth, and to confirm the results with those of a digital gadget (spectrophotometer).

AIM

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OBJECTIVES

AIM & OBJECTIVES

AIM

The aim of this study is to comparatively evaluate the colour match obtained with single shaded composite and the two universal shade composite restorative materials used.

OBJECTIVES

1. To comparatively evaluate the shade match obtained with universal shaded composite resin and the single shaded composite.
2. To evaluate the shade match obtained with Omnichroma (Tokuyama) both in anterior and posterior teeth in the cervical, incisal and occlusal areas.
3. To evaluate the shade match obtained with Charisma Topaz ONE (Kulzer) both in anterior and posterior teeth in the cervical, incisal and occlusal areas.
4. To comparatively evaluate the shade match obtained with Omnichroma and Charisma Topaz ONE in the cervical, incisal and occlusal areas.
5. To evaluate if the visual shade match is reliable with the help of a spectrophotometer.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

1. **Horn DJ, Bulan-Brady J, Hicks ML. (1998)** evaluated tooth shade objectively using human visual analysis and the SP78 spherical spectrophotometer. The findings of this study validate the unreliability of human tooth shade evaluation and the potential of the SP78 sphere spectrophotometer to offer a more reliable and accurate *in-vitro* tooth shade evaluation approach. [23]

2. **Lee YK, Powers JM (2004)** carried out a study to ascertain how the optical characteristics of the constituent layers affected the color of the double-layer aesthetic filling materials. Based on the optical values of the covering and underlying layers, several regression equations for the Commission Internationale de I'Eclairage (CIE) L*, a*, and b* of layered materials were computed. In the forward regression analysis, 14 optical values of the underlying and covering layers were utilized as independent variables, and each of the L*, a*, and b* layered materials was employed as a dependent variable. S, CIE a*, and CIE b* of the covering layer, respectively, have the greatest influence on the CIE L*, a*, and b* values of double-layer materials. [24]

3. **Lee YK, Lim BS, Kim CW. (2005)** examined how dental resin composites colors changed and differed from two widely used backgrounds. The color of five resin composites, both cured and uncured, was assessed using the CIELAB color scale using a reflection spectrophotometer with the SCE geometry and a white background. The color was measured in relation to the illuminant D65. Calculations were made to determine the color difference (DeltaE*ab) between each of the two backgrounds and the specimen circumstances. The three-color coordinates of CIE L*, a*, and b* values were impacted by the background in diverse ways based on the specimen condition and material. The specimen conditions had a major impact on the color coordinates and color difference due to background. [25]

4. **Paravina RD, Westland S, Imai FH, Kimura M, Powers JM. (2006)** conducted a study to assess the impact of translucency, starting color difference, and restoration size on the blending effect (BE) of resin composites *in-vitro*. The BE was computed using the variation in visual scores. First, a spectrophotometer was used to assess the specimen group in addition. The findings suggest that identifying and measuring the processes causing dental materials' color to move toward the color of neighboring teeth could enhance restoration aesthetics and make shade matching easier. [26]

5. **Klemetti E., Matela A.M., Haag P. & Kononen M. (2006)** used three distinct shade guidelines to assess inter-observer variability in porcelain repair shade choices. They concluded that a digital colorimeter might be a helpful teaching tool and that there is moderate to large inter-observer variation when choosing shades. [6]

6. **Derdilopoulou FV, Zantner C, Neumann K, Kielbassa AM. (2007)** evaluated the performance of visual and spectrophotometric tooth shade analysis in a study. Using the Chromascop-Complete shade guide, two operators independently chose the best match among 3758 anterior teeth belonging to 106 patients at three separate dates. Additionally, a reflectance spectrophotometer was used three times in a row to examine the color of the teeth. Spectrophotometry revealed strong agreement levels (89.6%), with 49.7% of the measurements agreed upon by both examiners. Ratings obtained by visual assessment were substantially darker than those obtained by spectrophotometry ($P <.0005$). For both processes, a positive correlation was noted ($P =.548$). [27]

7. **Yilmaz B, Karaagaclioglu L. (2008)** conducted a study to assess and contrast the repeatability and precision of two distinct shade determination techniques. Ten

patients had their maxillary right central incisors examined visually by five observers using the Vitapan Classical shade guide, and three times using the Vitapan Classical shade guide values of the ShadeEye NCC intra-oral colorimeter. Utilizing the spectrophotometric L*, a*, and b* readings of the shade guide (Vitapan Classical), the in vivo repeatability of the techniques was examined. It was determined that the readings of natural teeth using the intra-oral dental colorimeter achieved adequate repeatability. [28]

8. **Xu MM, Liu F, Zhang F, Ding Z. (2008)** conducted a study to assess the accuracy of Vita Easyshade's shade matching technique and compare it with spectrophotometric methods. In this study, 120 individuals with single anterior complete ceramic restorations were enrolled. Two groups—the visual shade matching group (Group V) and the spectrophotometric shade matching group (Group S)—were randomly allocated to the subjects. According to the study's findings, when applied to teeth with out-of-shade-tab color expression, the spectrophotometric (Vita Easyshade) shade matching method yields higher accuracy than visual shade matching. Compared to visual color matching, it offers superior color reappearance. [29]

9. **Kuzmanović D, Lyons KM. (2009)** evaluated the performance of an instrument-based colorimetry method against a traditional visual method for color matching. Ten randomly selected individuals had their maxillary right central incisors shaded by three dentists with normal color vision using a Vita Classical shade guide. Next, using the Shade Vision colorimeter, the tooth color of the identical teeth was ascertained. Using a colorimetric tool or a traditional visual assessment method did not significantly alter the shade selection accuracy, according to this study. However, there was some disparity when the two methods for choosing the shade of the same tooth were compared. [30]

10. **Kim BJ, Lee YK. (2009)** measured the variation in color and color coordinates across resin composites with the same shade designation from various brands and ascertained the impact of shade designation on the variation in color and color coordinates between them in a study. It was determined that in more than half of the examined pairs, there was a discernible color difference between the same shade-designated resin composite from different brands. This color difference varied depending on the shade designation. When choosing resin composites, the brand and shade designation should have a varied impact on the optical qualities of the material.[31]

11. **Lasserre JF, Pop-Ciutrila IS, Colosi HA. (2011)** Executed a study to Assess the Sopro 717 intraoral camera's innovative color matching Sopro Shade idea by contrasting it with the Vita 3DMaster shade guide under the True Shade lamp and the Vita Easyshade spectrophotometric technique. When compared to traditional visual procedures, it was determined that the Sopro Shade concept of the Sopro 717 intraoral camera is a dependable assistance to visual color assessment. [32]

12. **Özat PB, Tuncel İ, Eroğlu E. (2013)** conducted a study to analyse the human eye's consistency and dependability while choosing a visual shade. A group of fifty-four dentists volunteered to match the shade of one subject's upper right central incisor tooth. For the protocol, the Vita 3D-Master shade guide was utilized. The findings showed that while dentists can choose hues that are clinically appropriate, their performance in visual shade matching is not sufficiently consistent. [33]

13. **Alshiddi IF, Richards LC. (2015)** Compared the accuracy of shade selection using a spectrophotometer with a conventional method using a shade guide for

'trained' and 'untrained' students in a study. The 'untrained' group received no information or instruction, whereas the 'trained' group received a presentation and training exercise on color science and shade selection. Using both techniques, each student matched the maxillary right central incisor shade for eight test participants. The spectrophotometer proved to be more accurate than the visual approach in matching shade, but 'trained' students performed much better when matching the value visually than when using the spectrophotometer. Nevertheless, the spectrophotometric method was clearly more accurate. When utilizing the spectrophotometer, "untrained" pupils were more accurate in matching both the shade and the value. In conclusion, spectrophotometric devices were more accurate in matching the shade of natural teeth than traditional methods that use shade guides. However, the outcomes were greatly impacted by education and experience in color science and shade selection. [34]

14. **Glockner K, Glockner K, Haiderer B. (2015)** conducted a study to ascertain the tooth color using visual methods in natural light and the "Easy Shade" device. A sample of 500 patients was chosen for this study. The findings of the investigation demonstrated that shade matching with the "Easy Shade" device was not superior to shade matching with visual methods in natural light. There was no discernible difference between the visual and digital methods in terms of tooth shade selection. [35]

15. **Rasha M. Abdelraouf and Nour A. Habib (2016)** visually assessed color-matching and blending-effect (BE) of a universal shade bulk-fill-resin-composite. They performed spectrophotometric color measurement along with visual assessment to calculate color-difference (ΔE) between the universal shade and shaded-resin-composites discs along with restored cavities in extracted teeth. Based on obtained results, it was concluded that colour matching of universal shade resin composite is satisfactory rather than perfect in patients' teeth.[36]

16. **Igiel C, Weyhrauch M, Wentaschek S, Scheller H, Lehmann KM. (2016)** carried out a study to compare the visual shade identification with the agreement rate (%) and color difference (ΔE*ab) of three dental color-measuring devices. Two operators chose the tooth color together, and they were instructed to choose a VITA classic shade tab. To measure tooth color, three instruments were used: Shadepilot, CrystalEye, and ShadeVision. According to the findings, Shadepilot, CrystalEye, and ShadeVision all agreed on the visual shade determination by 56.3%, 49.0%, and 51.3%, respectively. The ΔE*ab of the natural teeth and visually and instrumentally selected shade tabs were often above the acceptable level. [37]

17. **Kalantari MH, Ghoraishian SA, Mohaghegh M. (2017)** evaluated the accuracy of shade matching using two spectrophotometric devices. Afterwards, shade matching was done for the first, second, and third crowns using the Vita Easyshade spectrophotometer, Shadepilot spectrophotometer, and Vitapan classical shade guide.The findings indicated that, although there were no significant differences between the Vita Easyshade and Shadepilot spectrophotometers ($P < 0.05$), both spectrophotometric systems produced much better results than the ocular technique. [38]

18. **Branka Trifkovic, John M. Powers, Rade D. Paravina (2017)** evaluated the color adjustment potential (CAP) of resin composites through visual and instrumental methods. According to the obtained results it was concluded that CAP was composite and shade dependent. Positive CAP was recorded both instrumentally and visually for most of the shades. Overall, the measured color difference reduction associated with positive CAP was found to be 31% while the average visual CAP was 43%. [39]

19. **Lehmann K, Devigus A, Wentaschek S, Igiel C, Scheller H, Paravina R. (2017)** implemented a study to evaluate how well spectrophotometric measurements and ocular shade matching performed. Using the visual approach, a total of 72.5% of tab pairs (or 11.6 tabs) were matched, while the spectrophotometer method yielded 98.9% of matches ($P < 0.001$). Results from female observers were substantially better than those from male observers ($P = 0.027$). [40]

20. **Liberato WF, Barreto IC, Costa PP, de Almeida CC, Pimentel W, Tiossi R (2018)** executed a study to evaluate the accuracy of several instrumental and visual techniques for matching tooth shades. Three skilled clinicians used two distinct shade guides (VITA Classical A1-D4 and VITA Toothguide 3D-MASTER with 29 tabs; VITA Zahnfabrik) to execute visual shade matching both with and without the use of a light-correcting device (Smile Lite; Smile Line). For color shade matching, a spectrophotometer (VITA Easyshade Advance 4.0) and an intraoral scanner (TRIOS; 3Shape A/S) were also utilized. The spectrophotometer set up for the VITA Classical scale and the intraoral scanner set up for the 3D-MASTER scale were found to have the best performance. It was determined that the visual approaches studied were not as dependable as the instrumental methods for color shade matching. [41]

21. **Joao Luiz Bittencourt de Abreu, Camila Sobral Sampaio, Ernesto Byron Benalcázar Jalkh, Ronaldo Hirata (2020)** evaluated colour matching of universal composite resin restorations using visual analysis and photographic analysis. On the basis of results obtained, they concluded that multishaded universal composites presented higher color matching than the single shade universal composite. There were no differences of color matching for different tooth shades for all composites.[42]

22. **Mona I. Riada, Wael M. Gamal, Ahmad S. Morsy (2020)** conducted a study to investigate the ability of the uni-shade restorative material to match the tooth shade and the blending effect of the single shade structurally colored universal resin composite. The results showed all color parameters in the two tests significant changes except (ΔL) in T2 which showed nonsignificant differences. The specimens showed a decrease in lightness and showed shifting toward the green and yellow direction, while in T2 they became lighter than the teeth and directed toward the green and blue scale. They concluded that OMNICHROMA matches the shade of enamel.[43]

23. **Rubinya Sundar Iyer, Vinti Rajendra Babani, Peter Yaman, Joseph Dennison (2020)** evaluated the shade match of three composite resin restorative materials to bi-layered acrylic teeth instrumentally and visually. The results on the instrumental evaluation displayed that Omnichroma and TPH Spectra show lower $\Delta E00$ values for lighter shades, whereas EvoCeram displays lower and similar $\Delta E00$ values for all shades. In the visual evaluation, EvoCeram exhibited the best shade match for darker shades C2 and D3. Omnichroma and TPH Spectra matched better with lighter shades. They concluded that shade matching is composite and shade dependent and EvoCeram has better shade match than the other two materials.[44]

24. **Cristina Lucenaa, Javier Ruiz-López b, Rosa Pulgar a, Alvaro Della Bona, María M. Pérez (2021)** conducted a study to evaluate optical properties, translucency and opalescence parameters of one-shaded resin-based composites. Three one-shaded resin composites (OM — Omnichroma; VP — Venus Pearl; and VD — Venus Diamond) and a group-shaded resin composite (FU- Filtek Universal A2) were used. OM showed the greatest translucency values for all thicknesses whereas VP and VD showed the lowest opalescent values. It was concluded that One-shaded resin-based composites show different optical behavior than the group-shaded resin-based composite.[22]

25. **Tabatabaian F, Beyabanaki E, Alirezaei P, Epakchi S. (2021)** carried out a study to determine the most accurate and precise shade selection technique currently used in dentistry. The study covered visual and digital shade taking methods, related effective elements and situations, and their accuracy and precision. As a result, 249 articles were taken into account. As a result, when compared to visual methods, digital methods exhibit greater accuracy and precision; yet, in order to attain optimal shade taking outcomes, accuracy needs to be improved. It was determined that, when compared to other shade selection techniques, dental spectrophotometers offer the highest level of overall accuracy and precision. However, in order to operate at their best, they require technological advancement and a clinical environment to manage relevant effective components and conditions. [45]
26. **Czigola A, Róth I, Vitai V, Fehér D, Hermann P, Borbély J. (2021)** performed research to assess the relationship between spectrophotometric and ocular shade determination. Using the Vita Easyshade spectrophotometer, Trios 3 intraoral scanner, Vita A1-D4 and Vita Linearguide 3D-Master guides, ten dental students from Semmelweis University were able to determine the tooth shade of ten subjects. The same patient was always the first and the last. Repeatability within an individual was computed. The study's conclusion was that the Trios 3 intraoral scanner can be utilized to visually verify shade choices using a 3D-Master tooth color system. [46]

27. **Rashid F, Farook TH, Dudley J. (2023)** conducted a study to evaluate the clinical results of digital systems with spectrophotometers and traditional visual methods, and to identify digital non-proximity recording equipment and related color spaces in dentistry. The evaluation evaluated 85 publications using predetermined criteria, resolving conflicts between two reviewers using Cohen's kappa calculator. Of those, 33 were included in a PICO model for clinical comparisons. The findings show that the CIELAB color space was used in 42% of the experiments. Non-proximity digital equipment, similar to spectrophotometers, showed more

consistent clinical outcomes than visual approaches, despite the problems in study quality, highlighting their efficacy in controlled conditions. [47]

MATERIALS

&

METHOD

MATERIALS AND METHODOLOGY

The present *in-vitro* study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow and Research Centre, ITS Dental College, Greater Noida.

Freshly extracted teeth belonging to the age group of 25-50 years reporting to the Outpatient Department of Babu Banarasi Das College of Dental Sciences were collected and sourced for this study. These freshly extracted teeth were first cleaned under running water and then stored in hydrogen peroxide solution for 10 minutes. After two hours the teeth were cleaned with an ultrasonic scaler. The teeth that met the inclusion and exclusion criteria were stored in distilled water till further use.

Eligibility Criteria:

Inclusion criteria

- Human permanent first mandibular molars and maxillary central incisors freshly extracted, free of any defects belonging to the patients of age group of 25-70 years.
- Teeth with fully formed and mature roots.

Exclusion Criteria

- Teeth with any abfraction, attrition, abrasion and erosion.
- Teeth with resorption or any dystrophic calcification in the pulp space.
- Teeth with restorations and endodontic treatment.
- Teeth with fracture or craze lines.
- Teeth with developmental malformations.
- Teeth with fluorosis, tetracycline stain or any stains due to endogenous conditions.

MATERIALS USED

TABLE A: MATERIALS USED

Table A.1: For sample preparation

1.	Airotor	NSK, Japan
2.	Diamond points	SS White
	Round	
	Flat end tapered fissure	
	Straight	
	Elongated pear shape	
	Inverted cone	
3.	Finishing diamond points	Shofu, Japan
4.	Straight probe	SS White, New Jersey
5.	Tweezer	SS white, New Jersey
6.	Ultrasonic scaler and tips	Coltene, Switzerland
7.	3% Hydrogen peroxide	Cymer, India
8.	Distilled Water	Waldent, India
9.	Kidney tray	IndiaMart, India
10.	Magnifying loupes (3.5x) and prismatic light	Zumax Medical Co. Ltd, China

Table A.2: For restoration

1.	Composite filling instruments	GDC, India
	Heidman filling spatula	
	Goldstein flexi thin	
	Paddle condensor	
	Freedman duckhead instrument	
	Beavertail Ball burnisher	
2.	Omnichroma	Tokuyama, Japan

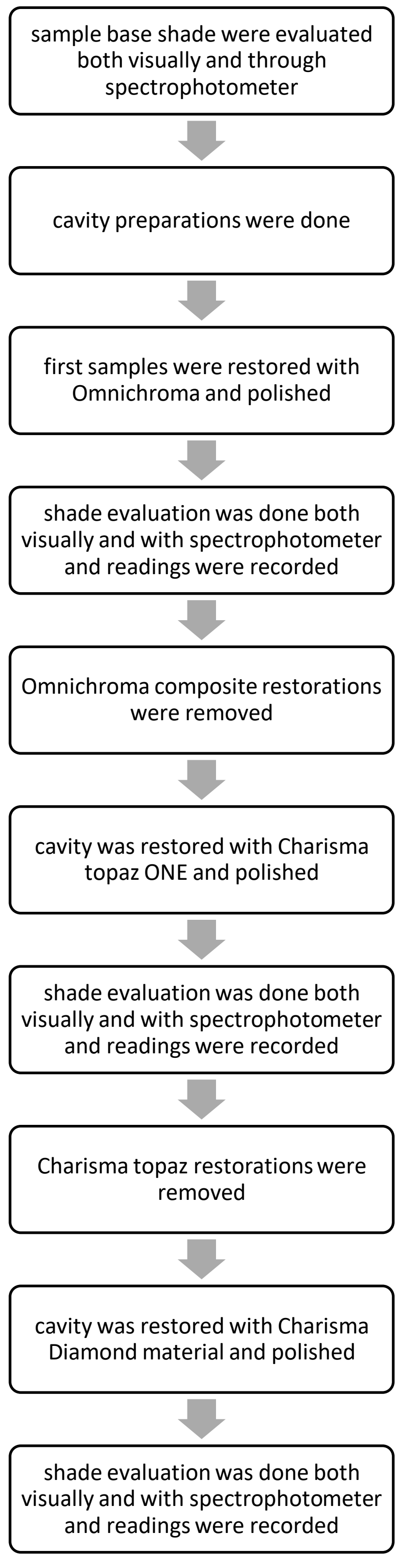
3.	Charisma Topaz ONE	Kulzer, Japan
4.	Charisma diamond	Kulzer, Japan
5.	Etchant (37% phosphoric acid)	Orikam, India
6.	Applicator tips	Green guava, India
7.	Gluma universal bonding agent	Kulzer, Japan
8.	Shofu polishing kit	Shofu, Japan
9.	Micromotor handpiece	SS white, New Jersey
10.	Micromotor unit	Marathon, India
11.	Curing light	Ivoclar, USA

Table A.3: For evaluation

1.	Spectrophotometer	3nh, China
2.	VITAPAN classical shade guide	VITA Zahnfabrik, Germany

METHODOLOGY

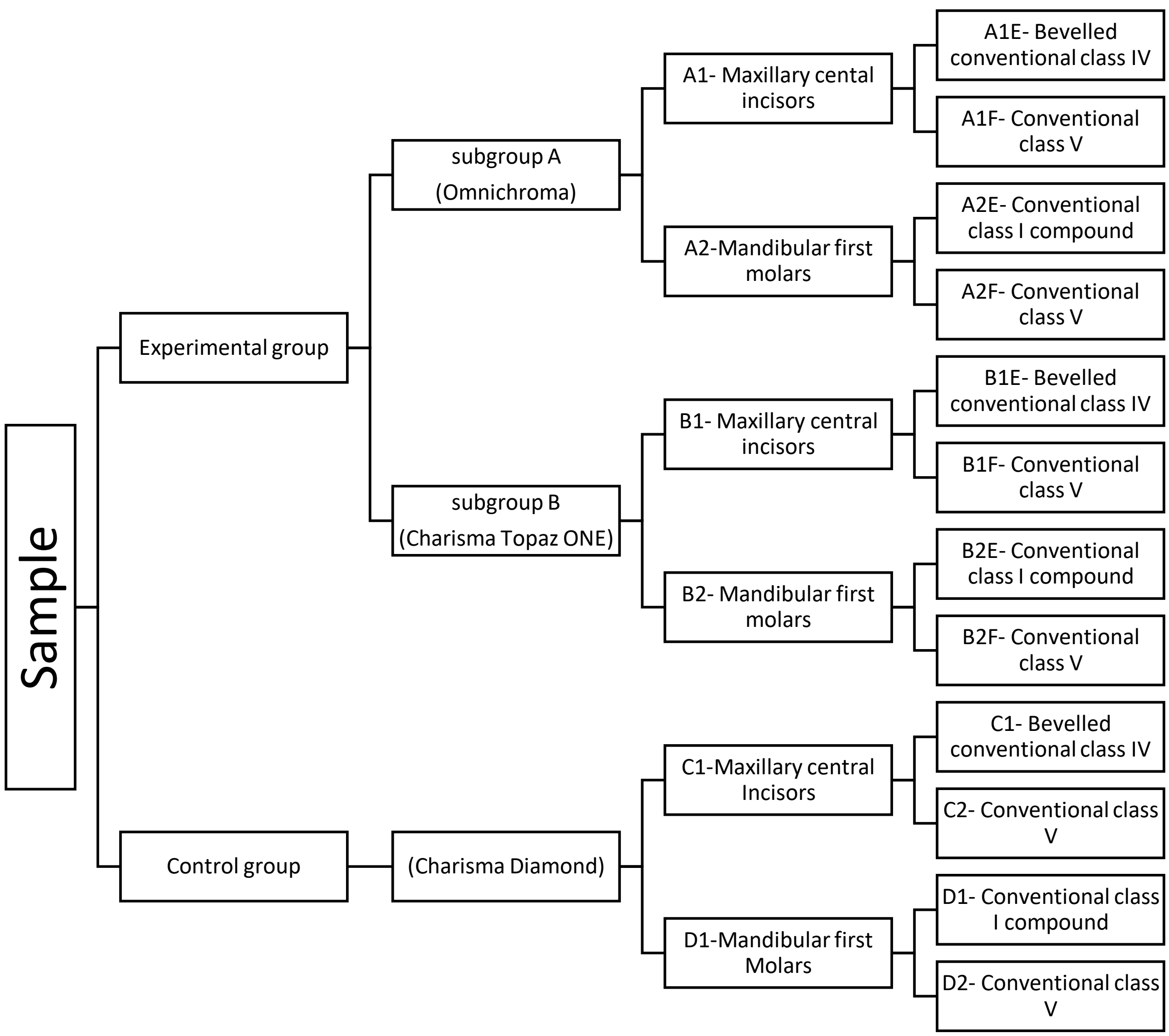
Flowchart 1: Method of the study.



SAMPLE PREPARATION

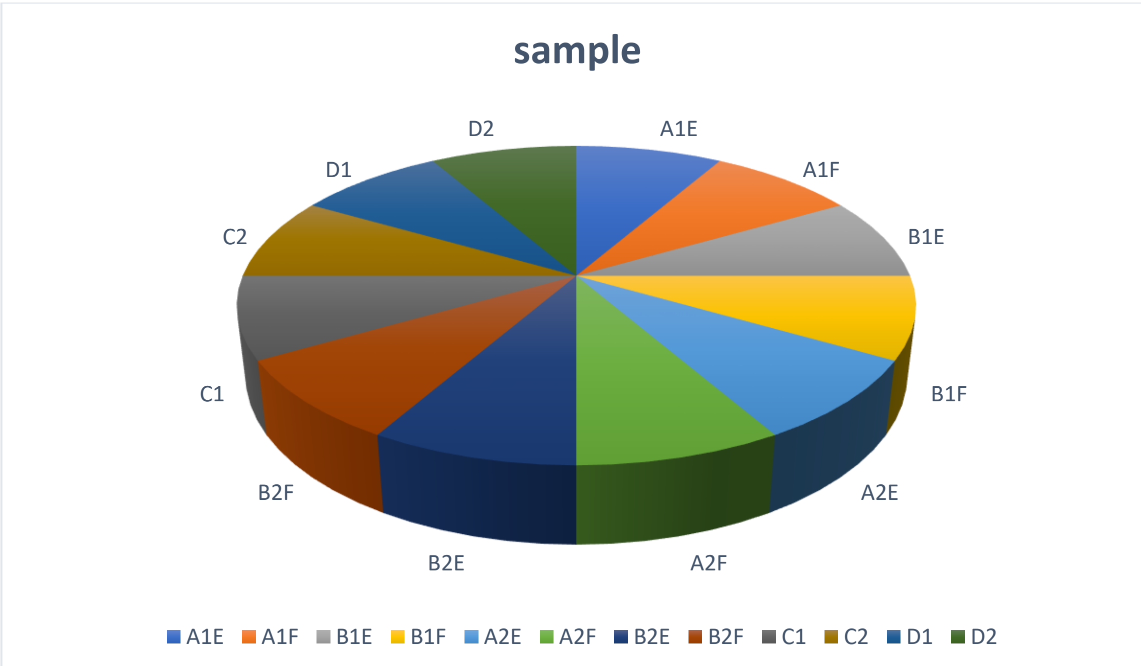
A total of 80 teeth were selected for the study to be restored thrice with the chosen materials for the study. These teeth first chosen as experimental group A and were restored with Omnichroma, then chosen as experimental group B and were restored with Charisma Topaz ONE and then chosen as the control group C were restored with Charisma Diamond composite materials.

Flowchart 2: Sample distribution



Division of the samples:

Graph A: Sample distribution



Control group:

In the control group the selected anterior teeth were placed in group C (40 in number) that were restored with Charisma Diamond composite. These were equally subdivided into division C1(20 in number) and C2(20 in number). In the samples placed in division C1 class IV cavity was prepared, whereas in division C2 class V cavity was prepared in the cervical third.

Similarly, the selected posterior teeth were placed in group D (40 in number). These were equally subdivided into division D1(20 in number) and D2(20 in number). In the samples placed in division D1 class I compound cavity was prepared whereas in division D2 class V cavity was prepared in the cervical third.

Experimental group:

In the experimental group the selected samples (80 in number) were taken into subgroup A (80 in number) and B (80 in number).

Teeth in subgroup A were restored with Omnichroma. The anterior teeth were placed in division A1(40 in number). These were further equally subdivided into A1E (20 in number) and A1F (20 in number). In subdivision A1E class IV cavity was prepared whereas in subdivision A1F class V cavity was prepared in the cervical third. The posterior teeth were placed in division A2(40 in number). These were further subdivided into A2E (20 in number) and A2F (20 in number). In subdivision A2E class I compound cavity was prepared whereas in subdivision A2F class V cavity was prepared in the cervical third.

Teeth in subgroup B are restored using Charisma Topaz ONE. The anterior teeth were placed in division B1(40 in number). These are further subdivided into B1E (20 in number) and B1F (20 in number). In subdivision B1E class IV cavity was prepared while in B1F class V cavity was prepared in the cervical third. The posterior teeth were placed in division B2(40 in number). These were further subdivided into B2E (20 in number) and B2F(20 in number). In subdivision B2E class I compound cavity was prepared whereas in subdivision B2F class V cavity was prepared in the cervical third.

Prior to the preparation of the cavity each sample was subjected to shade evaluation of the third where a cavity was prepared with the help of a Spectrophotometer and visually. The obtained shade was enlisted.

For cavity preparation

The cavities were prepared using an airotor and diamond points under magnifying loupes for magnification with prismatic light for illumination..

Class V cavity preparation:

The location of this cavity was in the cervical third of the tooth.

The site was dependent on the width of the tooth. The tooth was measured mesiodistally in the cervical third. The cavity was prepared at the centre of the distance measured.

In conventional class V tooth preparation, shape of the preparation was a “box” type.

1. Isolation of the area was done, and a tapered fissure bur was used to make entry at 45 degrees angle to tooth surface initially.

2.After this, long axis of bur was kept perpendicular to the external surface to get a cavosurface angle of 90 degrees.

3. During initial tooth preparation, the axial depth of 0.8 mm into the tooth was maintained.

4. After achieving the desired distal extension, the bur was moved mesially, incisally/ occlusally) and gingivally for placing the preparation margins onto the sound tooth surface while maintaining a cavosurface margin of 90 degrees.

5. Axial wall follows the contour of facial surface incisogingivally and mesiodistally. At this stage, all the external walls appeared outwardly divergent.

6. Finally, cleaning of the tooth preparation with water was done and was air dried.

7. Placement of bevel was done on the entire cavosurface margin of the prepared class V cavity.

Dimensions of class V cavities:

Length(mesiodistally): 1.5 mm

Height (cervicoincisally/ cervicocclusally): 1.5 mm

Depth: 1 mm

Class IV cavity preparation:

Box-like preparation was made with facial and lingual walls parallel to long axis of tooth involving the mesioincisal line angle.

1. Cavity was initiated from the incisal surface with a no. ½, 1 or 2 round bur and the bur was moved in incisogingival direction.

2. Initial depth of axial wall was 1.5 mm

3. Axial wall follows the contour of tooth, i.e. shape of axial wall was convex outwardly.

4. The external walls of tooth preparation were kept perpendicular to the enamel surface with all enamel margins bevelled.

5. Bevels were prepared using flat end tapering fissure diamond bur at cavosurface margins. Bevels were 0.2 to 0.5 mm wide at an angle of 45 degree to external tooth surface.

6. Bevel were not placed in areas bearing heavy occlusal forces i.e. incisal area.

The palatal surface was kept intact whereas the facial surface was involved in the cavity preparation.

Dimensions of class IV cavities:

Length (incisocervically):1.5 mm

Width: 1.5mm

Depth: 2 mm

Axially:1.5 mm

Cervical floor width: 1.5 mm

Class I compound cavity preparation

1. The tooth was entered in the occlusal area, with the elongated pear diamond. The bur is positioned parallel to the long axis of the crown.

2. The pulpal floor is prepared to an initial depth of approximately 2 mm. The instrument moved mesially, following the central groove, and any fall and rise of the DEJ.

3. Extensions into marginal ridges resulted in at least 2 mm remaining for molars.

4. An extension was prepared towards facial groove radiating from the occlusal surface onto the facial surface. The length of the cavity was in the mesiodistal direction. The entire length was measured and an extension onto the facial surface was made at the centre.

The dimensions of Class I compound cavities:

Length (mesiodistally): 2 mm

Width (buccolingually): 1.5 mm

Depth: 2 mm

Facial box length: 1 mm

Restoration

Restoration was done under magnifying loupes. For restoration the same bonding agent was used in both the experimental and control group. For the control group, restoration is carried out with Charisma Diamond composite resin using oblique layering technique. Composite restoration was placed in small increments (2mm) to reduce polymerization shrinkage (4-7% shrinkage). First increment of composite using a plastic instrument was placed, packed and cured for 20 to 30 seconds. Subsequent increments were added and cured till the complete preparation is filled.

In experimental group, the prepared cavities were restored with their respective group composites; Group A with Omnichroma (Tokuyama) and group B with Charisma Topaz ONE (Kulzer) using bulkfill technique.

The restoration was then finished using finishing burs and polished using shofu polishing kit.

For shade evaluation

Prior to start of the cavity preparation, base line shade evaluation of the third, where the cavity was to be prepared was carried out in each tooth sample.

After restorations were completed, Shade evaluation was carried out in two stages. In stage 1 shade evaluation was carried out visually by two uninvolved observers, independently. The restored third of the tooth was evaluated by the two observers based on predefined criteria. A customized evaluation scale was utilized for shade evaluation consisting of grades I-III.

Grade I- Excellent (No difference present between the tooth structure and restorative material)

Grade II- Good (A discrepancy between tooth structure and restorative material visible with clear interfacial demarcation)

Grade III- Poor (The shades of the tooth structure and restorative material distinctively different with obvious interfacial margin)

In stage 2, shade evaluation was carried out with the help of a Spectrophotometer, at an observer angle of 10 degree and D65 illuminant on a grey background of the restored third in each sample.

Figure1: Ultrasonic Scaler


Figure 2: Distilled Water


Figure 3: Normal Saline

Figure 4: VITAPAN Classical shade guide


Figure 5: Micromotor with Unit


Figure 6: Airotor

PLATE I

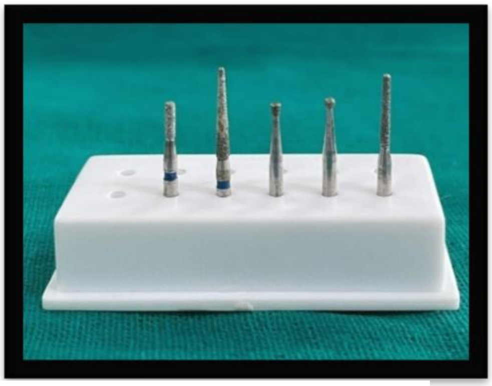


Figure 7: Cavity Preparation diamond point

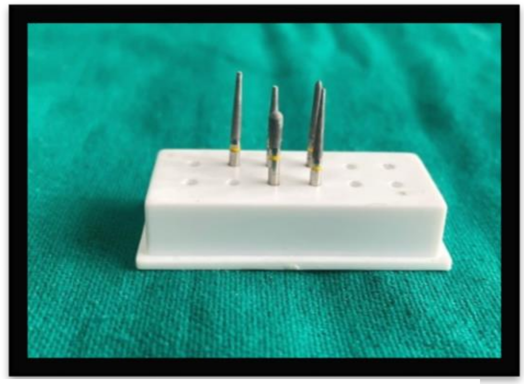


Figure 8: Finishing diamond point

Figure 9: Kidney tray, tweezer & straight probe

Figure 10: Zumax Loupes

Figure 11: Hydrogen Peroxide

Figure12: Etchant, Bonding Agent & Applicator Tips

PLATE II

Figure 13: Composite filling Instruments

Figure 14: Composite polishing discs

Figure 15: Curing Light

PLATE III

Figure 16: Collected samples

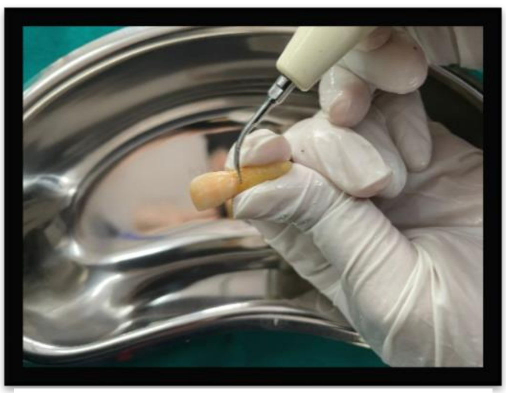


Figure 17: Scaling of incisor samples

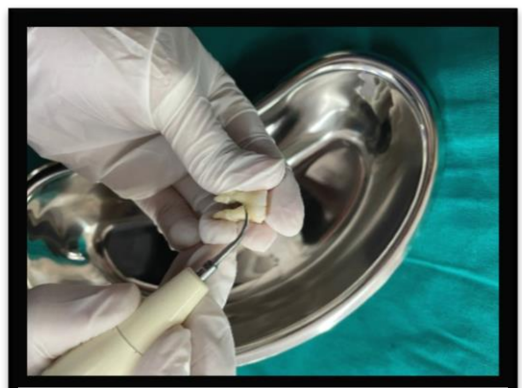


Figure 18: Scaling of molar samples

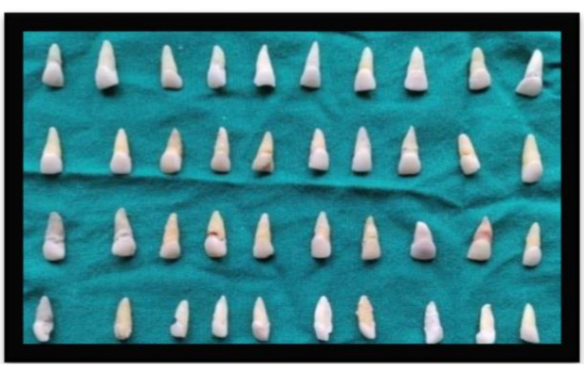


Figure 19: Obtained Incisor Samples

Figure 20: Obtained molar samples

PLATE IV

Figure 21: occlusal class I compound cavity

Figure 22: buccal extension for class I compound cavity

Figure 23: Prepared class I compound cavity

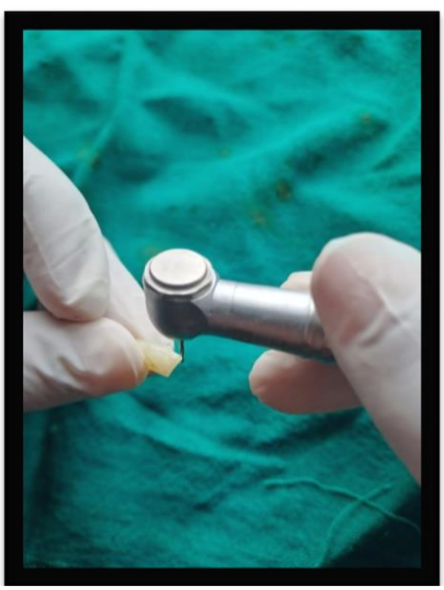


Figure 24: Class IV Cavity Preparation

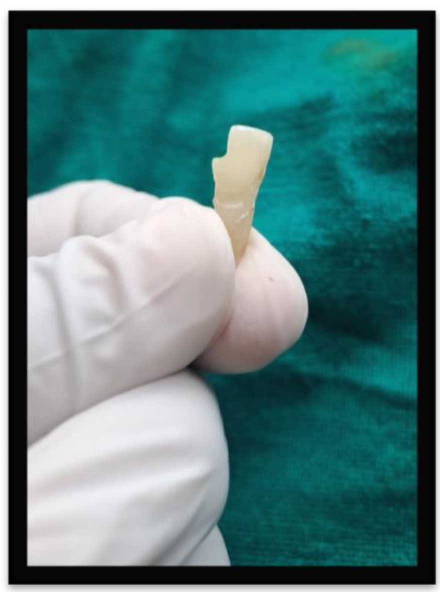


Figure 25: Prepared Class IV cavity

PLATE V

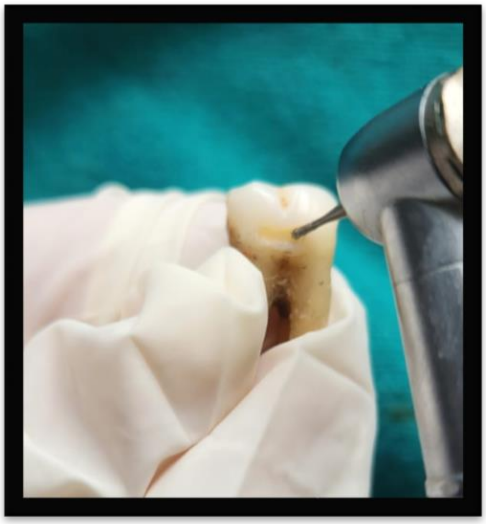


Figure 26: Preparation of Class V cavity on molar

Figure 27: Prepared Class V cavity on molar

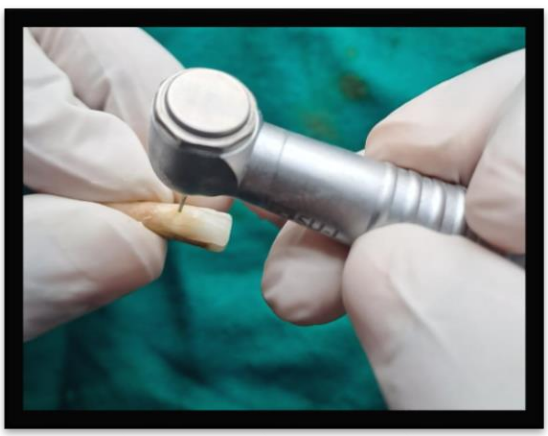


Figure 28: Preparation of Class V cavity on incisor

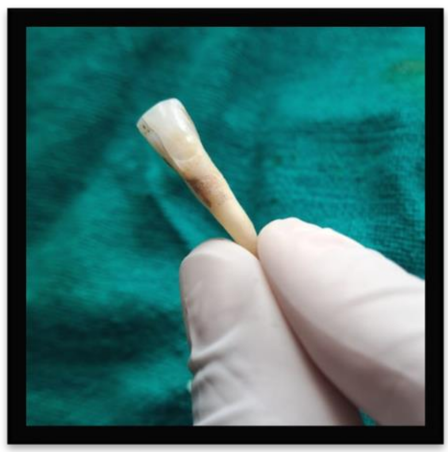


Figure 29: Prepared Class V cavity on incisor

PLATE VI

Figure 30: Omnichroma, material for Subgroup A

Figure 31: Etching of molar sample (Class I compound)

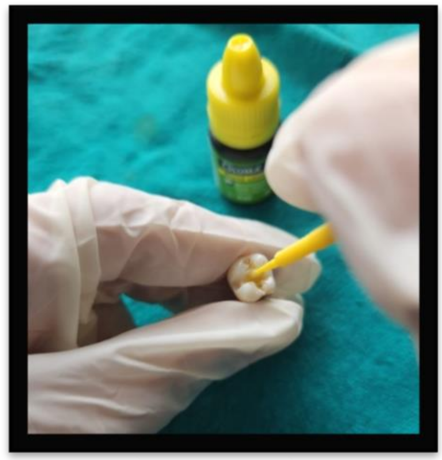


Figure 32: Bonding agent application on molar sample (Class I compound)

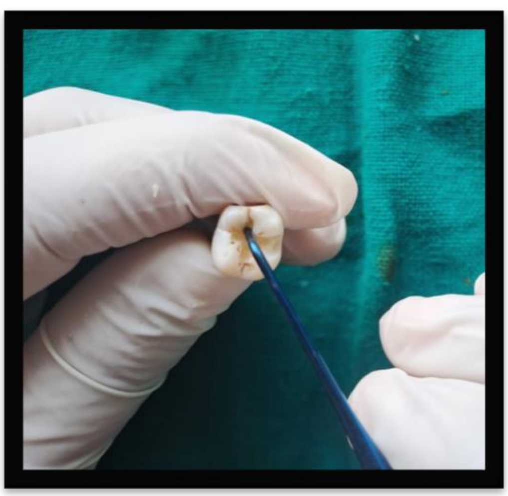


Figure 33: Restoration with Omnichroma on molar sample (Class I compound)

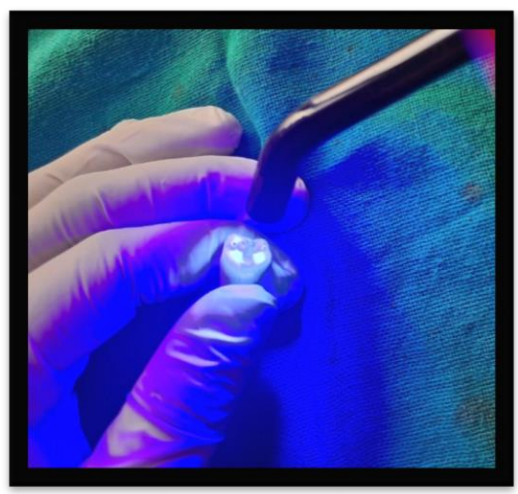


Figure 34: Curing of restoration on molar sample (Class I compound)

<u>PLATE VII</u>

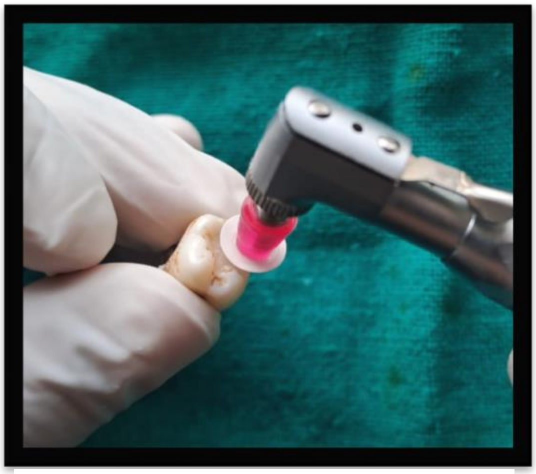


Figure 35: Polishing of restoration of molar sample (Class I compound)

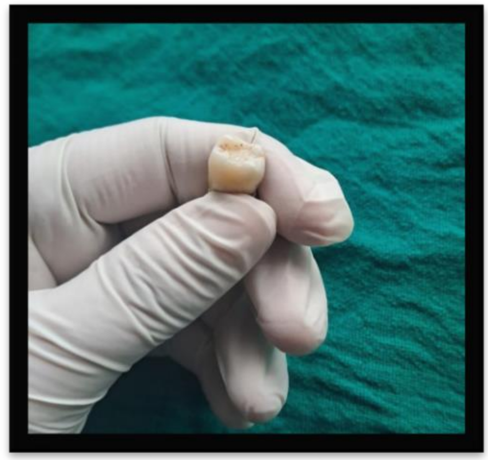


Figure 36: Restored molar sample (Class I compound)

Figure 37: Etching of sample (Class IV)

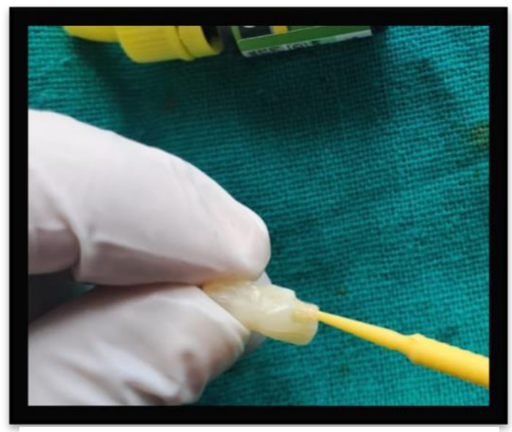


Figure 38: Bonding agent application of sample (Class IV)

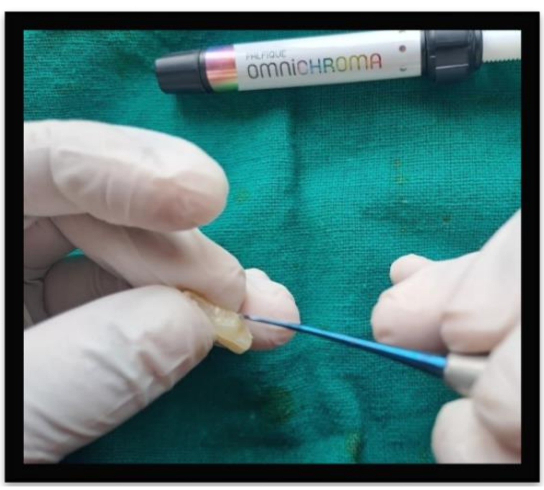


Figure 39: Restoration of Incisor sample (Class IV)

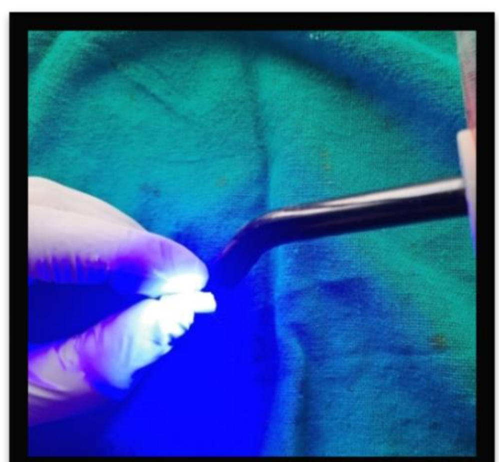


Figure 40: Curing of incisor sample (Class IV)

PLATE VIII

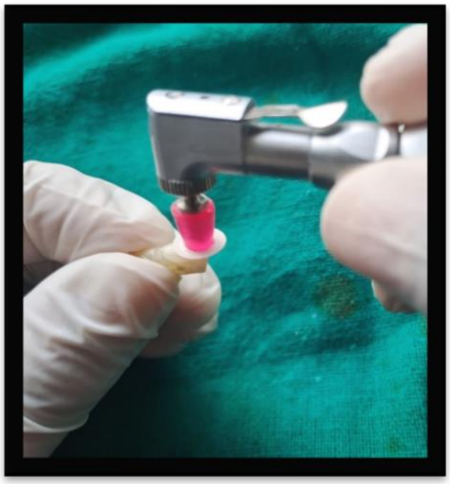


Figure 41: Polishing of Incisor sample (Class IV)

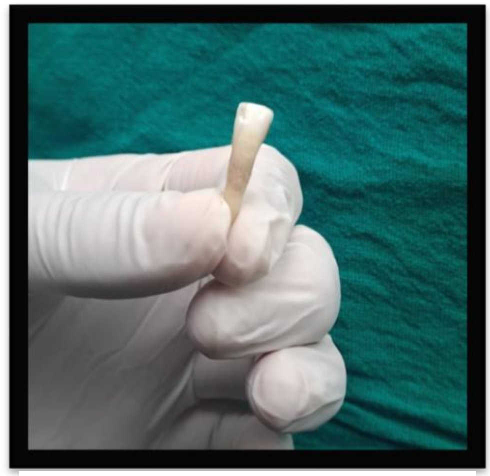


Figure 42: Restored Incisal sample (Class IV)

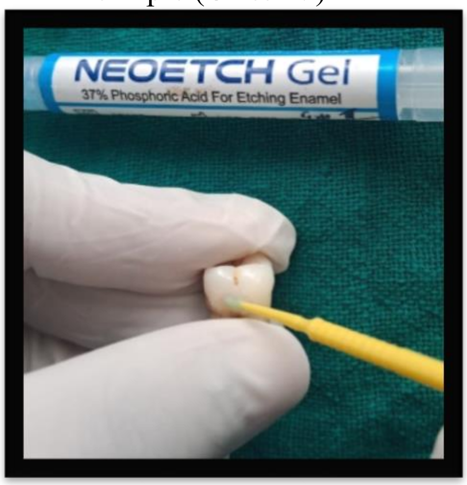


Figure 43: Etching on molar sample (Class V)

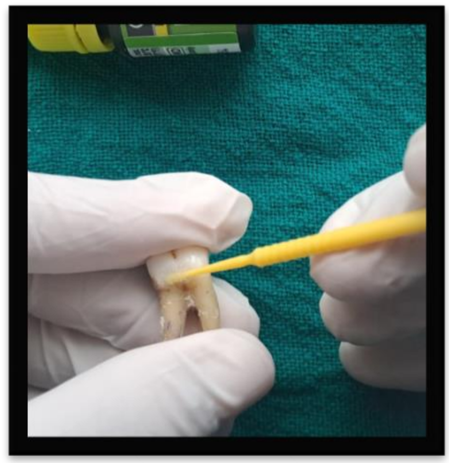


Figure 44: Bonding agent application on molar sample (Class V)

Figure 45: Restoration of molar sample (Class V)

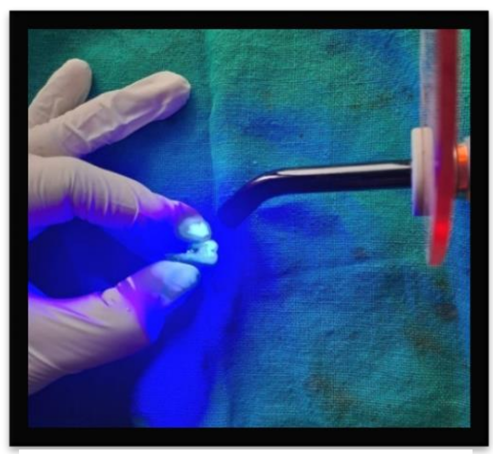


Figure 46: Curing of molar sample (Class V)

PLATE IX

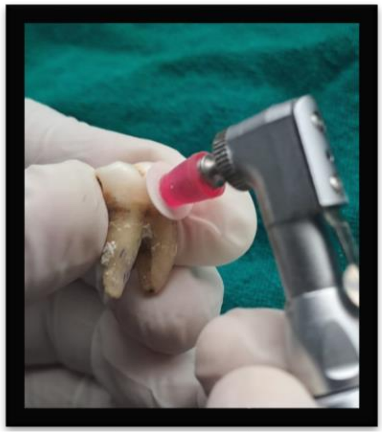


Figure 47: Polishing of molar sample (Class V)

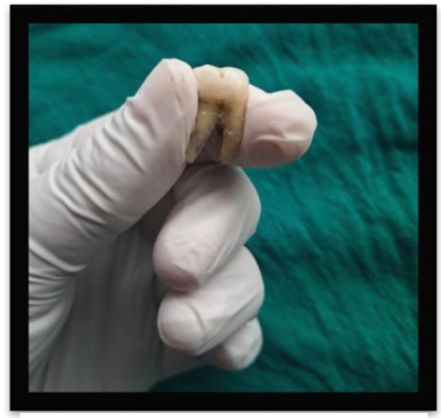


Figure 48: Restored molar sample (Class V)

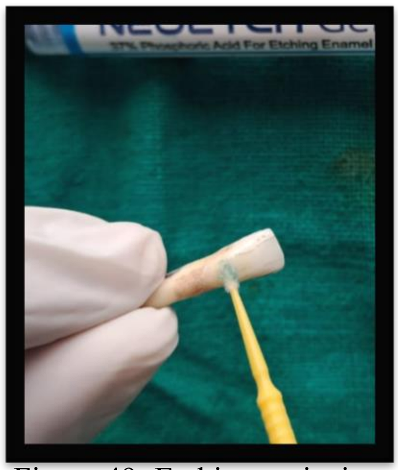


Figure 49: Etching on incisor sample (Class V)

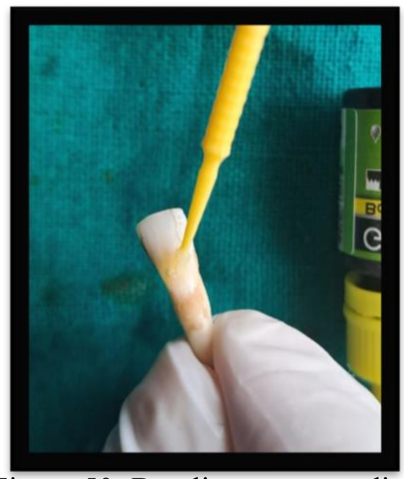


Figure 50: Bonding agent application on incisor sample (Class V)

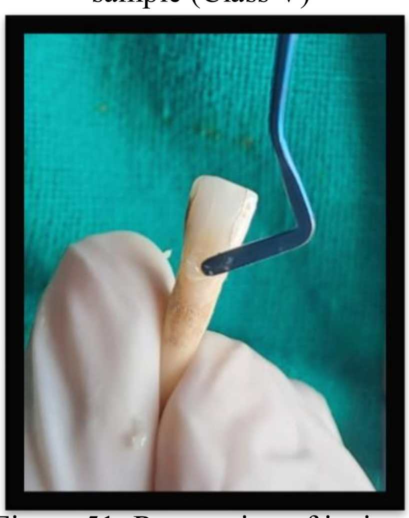


Figure 51: Restoration of incisor sample (Class V)

Figure 52: Curing of incisor sample (Class V)

PLATE X

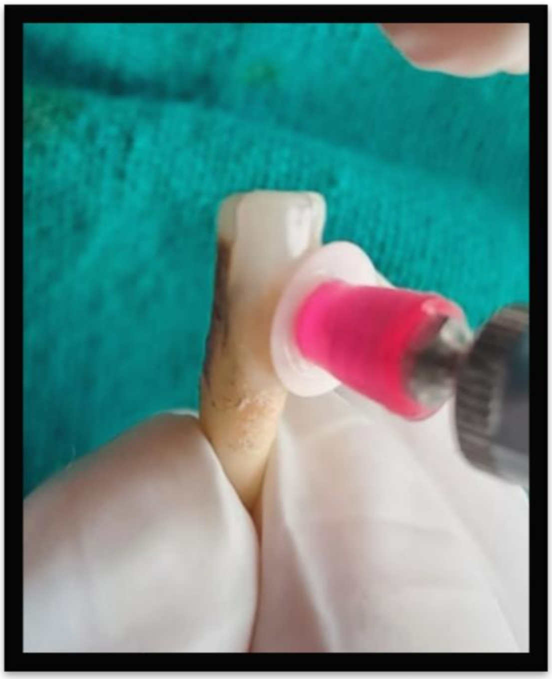


Figure 53: Polishing of Incisor sample (Class V)

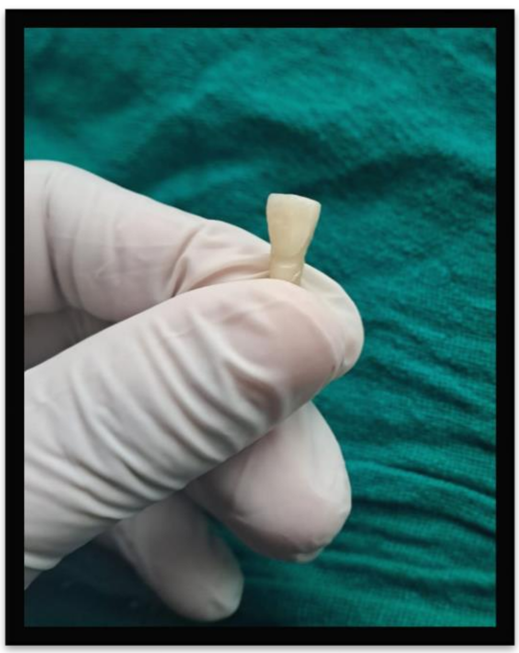


Figure 54: Restored Incisor sample (Class V)

PLATE XI

Figure 55: Charisma Topaz ONE, material for subgroup B

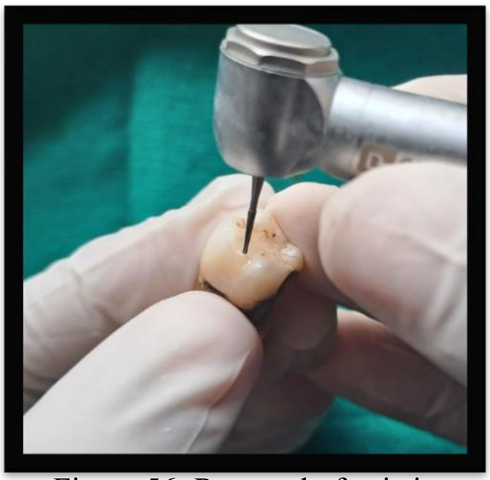


Figure 56: Removal of existing Restorations from molar samples for subgroup B

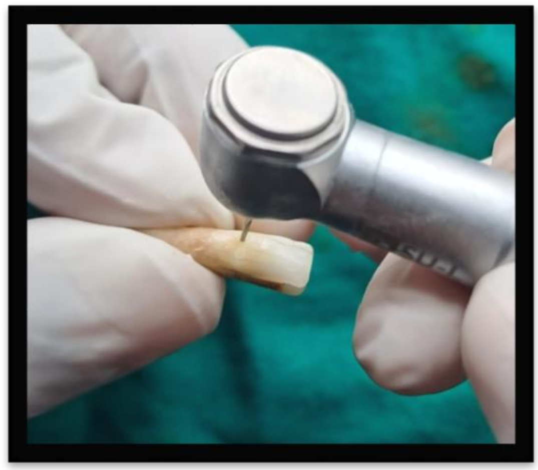


Figure 57: Removal of existing Restorations from incisor samples for subgroup B

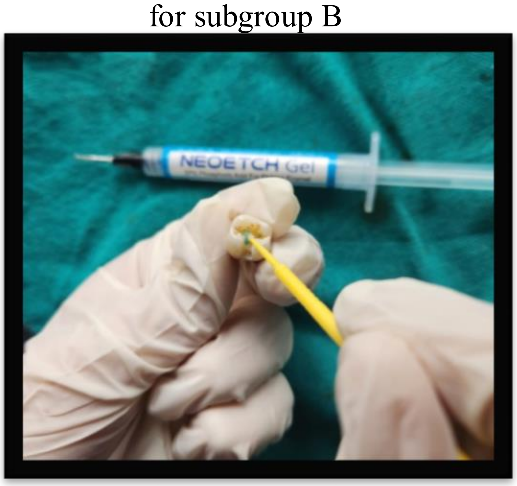


Figure 58: Etching of samples for subgroup B

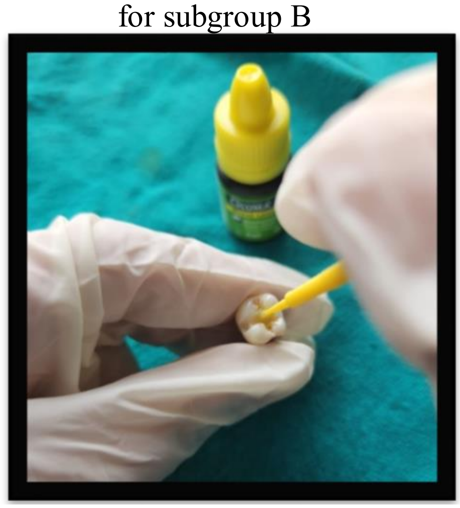


Figure 59: Bonding agent application of samples for subgroup B

<u>PLATE XII</u>

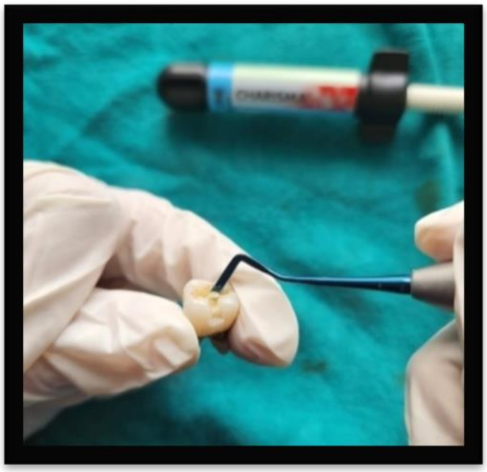


Figure 60: Restoration of samples with Charisma Topaz ONE

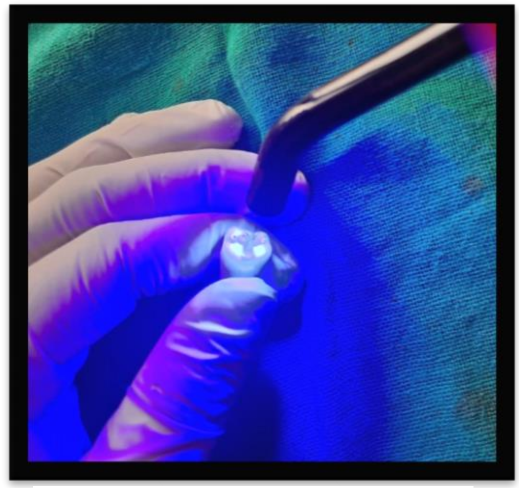


Figure 61: Curing of samples for subgroup B

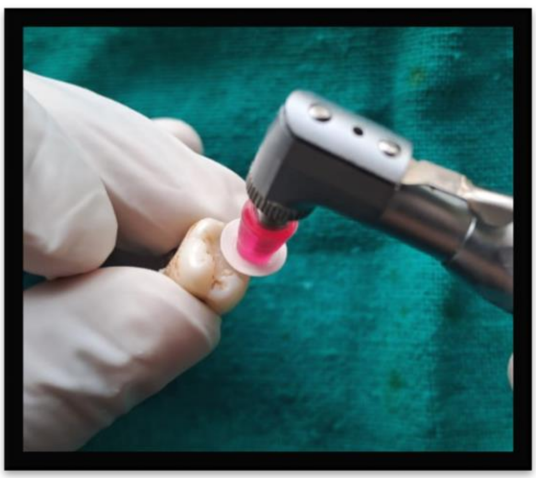


Figure 62: Polishing of samples for subgroup B

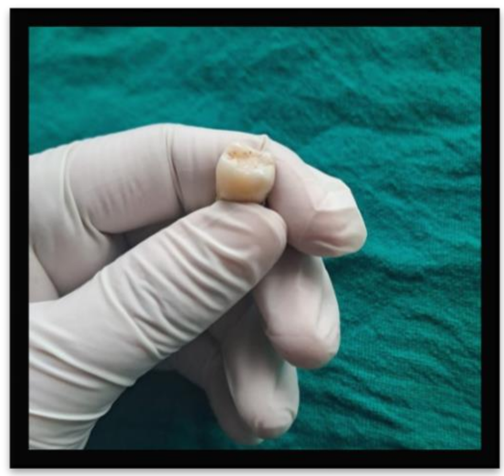


Figure 63: Restored samples for subgroup B

PLATE XIII

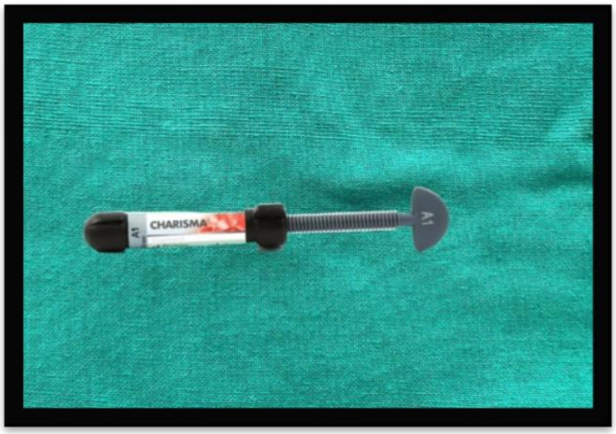


Figure 64: Charisma Diamond, material for subgroup C

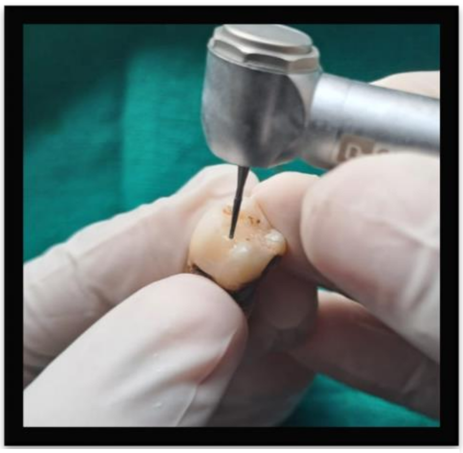


Figure 65: Removal of existing restorations from molar samples for subgroup C

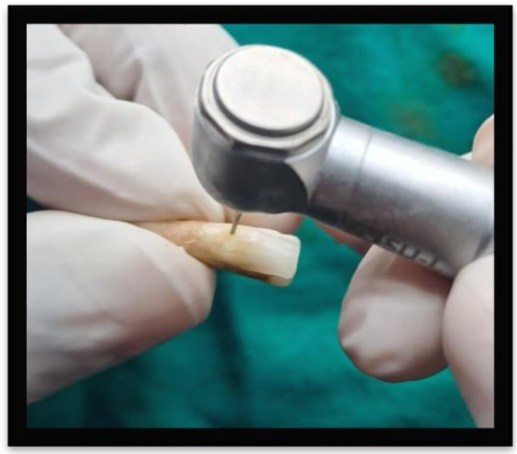


Figure 66: Removal of existing restorations from incisor samples for subgroup C

Figure 67: Etching of samples for subgroup C

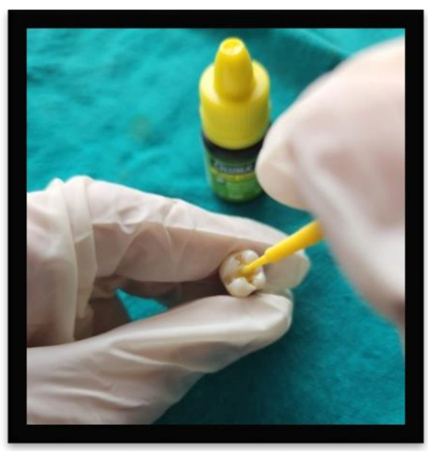


Figure 68: Bonding agent application of samples for subgroup C

PLATE XIV

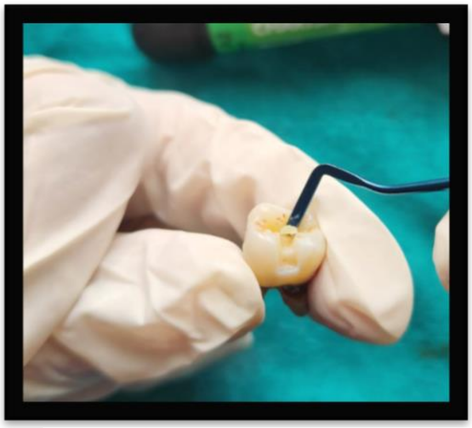


Figure 69: application of dentin layer with Charisma Diamond

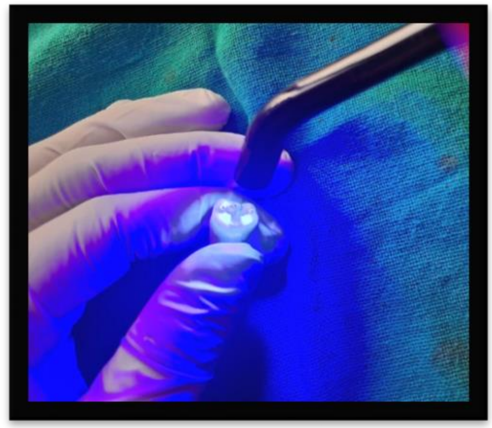


Figure 70: curing of dentin layer with Charisma Diamond

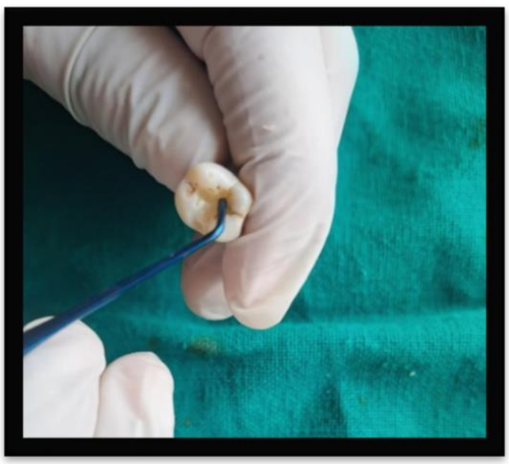


Figure 71: Restoration of samples with Charisma Diamond for subgroup C

Figure 72: Curing of samples for subgroup C

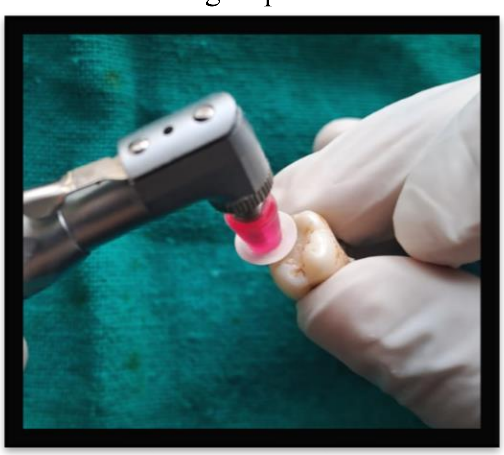


Figure 73: Polishing of samples for subgroup C

Figure 74: Restored samples for subgroup C

PLATE XV

Figure 756: Spectrophotometer

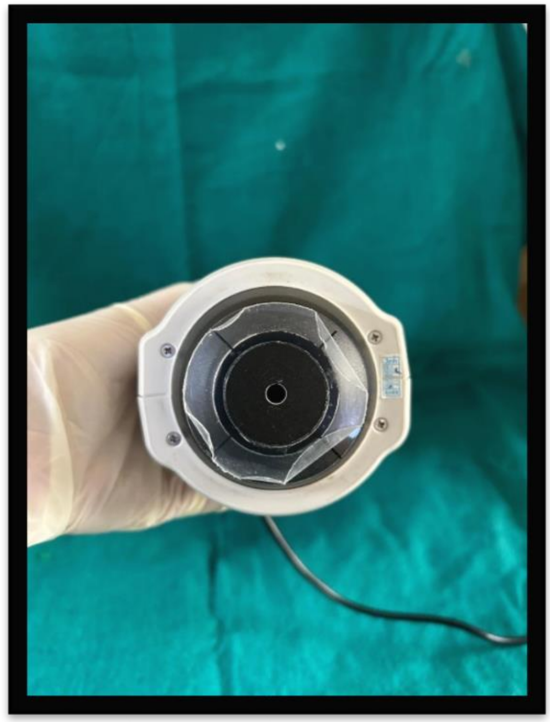


Figure 765: 4mm aperture of Spectrophotometer

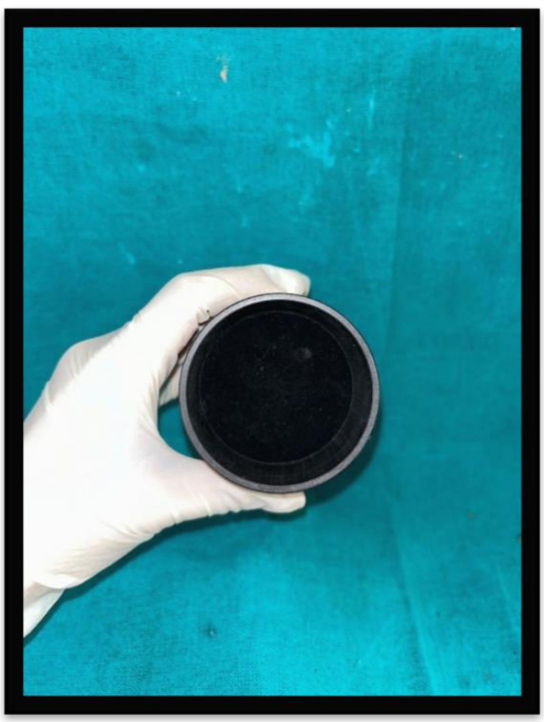


Figure 774: Black filter

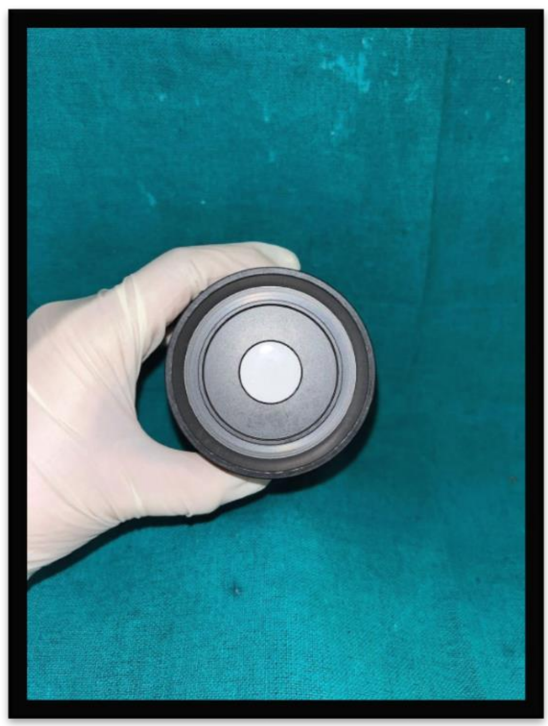


Figure 78: Whiteboard of Spectrophotometer

PLATE XVI

RESULTS

RESULTS

Analysis was done using unpaired t-tests. The data was statistically analysed using SPSS version 20.

Table 1: Comparison between the restoration by Omnichroma and Charisma Topaz ONE

		After Charisma Topaz one			P-value
		Discrepancy	Good	Total	
After Omnichroma	Discrepancy	8	11	19	0.306
	Good	18	43	61	
	Total	26	54	80	

The above table shows the comparison between the restoration by Omnichroma and Charisma Topaz ONE in comparison to the change in VITA shade from base shade. The results shows that there was statistically insignificant difference between the two groups ($p>0.05$) but with better results in Omnichroma as compared to Topaz ONE.

Table 2: Comparison between the restoration by Omnichroma and Charisma Diamond

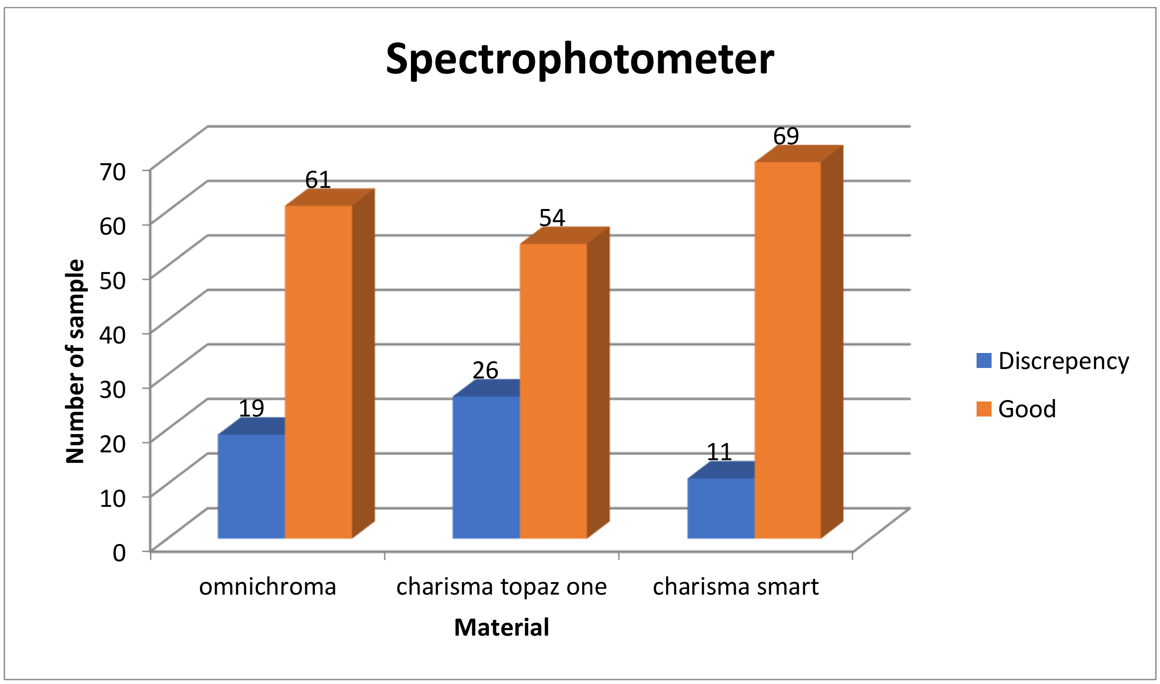
		After Charisma Diamond			P-value
		Discrepancy	Good	Total	
After Omnichroma	Discrepancy	0	19	19	**0.046**
	Good	11	50	61	
	Total	11	69	80	

The above table shows the comparison between the restoration by Omnichroma and Charisma Diamond in comparison to the change in VITA shade from base shade. The results shows that there was statistically significant difference between the two groups ($p<0.05$), superior results in Charisma Diamond as compared to Omnichroma.

Table 3: Comparison between the restoration by Charisma Diamond and Charisma Topaz ONE

		After Charisma Diamond			P-value
		Discrepancy	Good	Total	
After Charisma Topaz ONE	Discrepancy	0	26	26	**0.013**
	Good	11	43	54	
	Total	11	69	80	

The above table shows the comparison between the restoration by Charisma Topaz ONE and Charisma Diamond in comparison to the change in VITA shade from base shade. The results shows that there was statistically significant difference between the two groups ($p<0.05$), with more good results in Charisma Diamond as compared to Omnichroma.



Graph 1: Spectrophotometric comparison

Table 4: Visual comparison between the restoration by Omnichroma and Charisma Topaz ONE

Grading of shade match		After Charisma Diamond				P-value
		Excellent	Good	Poor	Total	
After Omnichroma	Excellent	51	12	0	63	**0.031**
	Good	9	0	1	10	
	Poor	4	2	1	7	
	Total	64	14	2	80	

The above table shows the comparison of grading of shade match between Omnichroma and Charisma Diamond in comparison to the shade change in VITA shade from base shade. The results shows that there was statistically significant difference between the two groups ($p<0.05$), with superior results in Omnichroma as compared to Charisma Diamond.

Table 5: Visual comparison between the restoration by Omnichroma and Charisma Topaz ONE

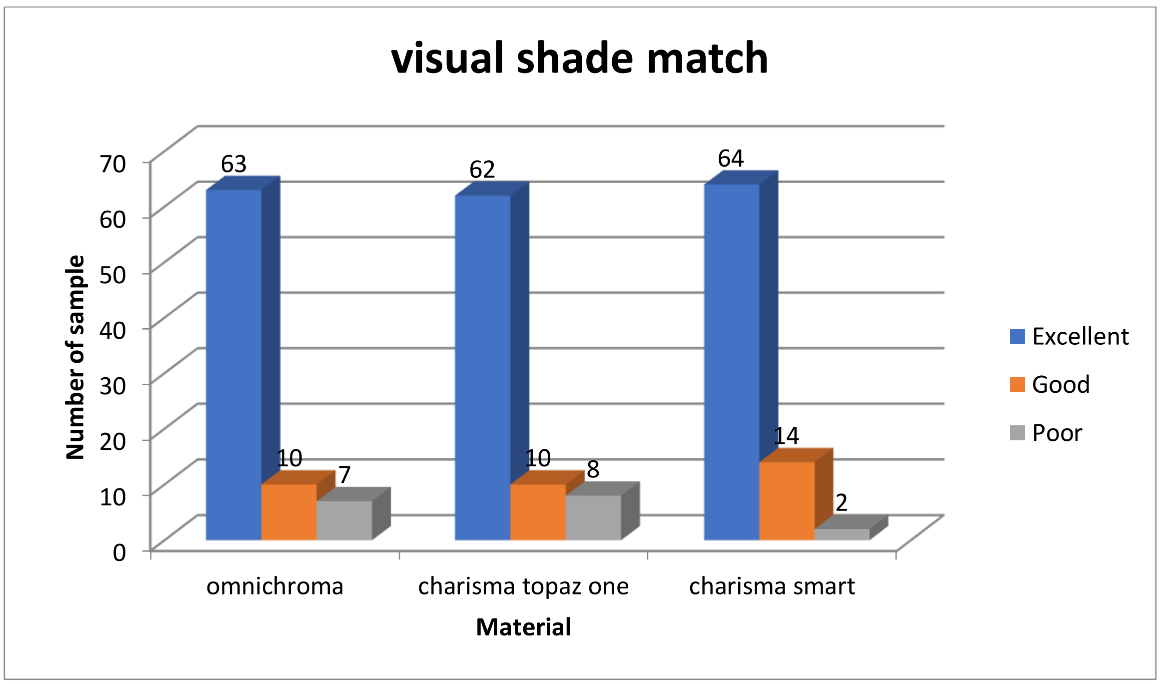
Grading of shade match		After Charisma Topaz ONE				P-value
		Excellent	Good	Poor	Total	
After Omnichroma	Excellent	50	9	4	63	0.243
	Good	7	1	2	10	
	Poor	5	0	2	7	
	Total	62	10	8	80	

The above table shows the comparison of grading of shade match between Omnichroma and Charisma Topaz ONE in comparison to the shade change in VITA shade from base shade. The results shows that there was statistically insignificant difference between the two groups (p>0.05), with more excellent results in Omnichroma as compared to Charisma Topaz ONE.

Table 6: Visual comparison between the restoration by Charisma Diamond and Charisma Topaz ONE

Grading of shade match		After Charisma Diamond				P-value
		Excellent	Good	Poor	Total	
After Charisma Topaz ONE	Excellent	50	11	1	62	0.430
	Good	8	2	0	10	
	Poor	6	1	1	8	
	Total	64	14	2	80	

The above table shows the comparison of grading of shade match between Charisma Topaz ONE and Charisma Diamond in comparison to the shade change in VITA shade from base shade. The results shows that there was statistically insignificant difference between the two groups (p>0.05), with better results in Charisma Diamond as compared to Charisma Topaz ONE.



Graph 2: Visual comparison

DISCUSSION

DISCUSSION

The color of the composite resin and the native tooth structure must be so comparable for a restoration to be deemed aesthetically acceptable that the human eye cannot distinguish between the two. (48) It is advised to use layering techniques while performing composite resin restorations. Even though this approach of color matching works quite well, it takes more clinical time and significant professional talent to do. [42]. Therefore, the emergence of new techniques is expected to facilitate clinical protocols, reduce clinical time, and facilitate the color selection process in dentistry, which is challenging.

Single-shade composite resins have recently been introduced to the market based on this principle of color mixing. No matter what color the tooth needs to be restored, these materials are made to precisely match the surrounding tooth color. [22]. These resins exhibit a phenomenon called the “chameleon effect” or “mixing effect,” which refers to the ability of a material to combine and acquire a color like that of its surrounding structures [49]. This means that two colors, when seen side by side, will mix under the right conditions so that the perceived color of a region changes to that of the surrounding area [22]. These composite resins have the advantage of being able to simulate all shades of tooth color using only a single shade [18]. These materials are very promising for use in clinical practice because of all the qualities, especially when contrasted to materials that require numerous colors to complete lengthy restorations. [50]

Omnichroma (OC), single-color composite resin, was the first genuinely developed single-tone composite resin purported to have the potential to match all 16 Vita Classical shades, ranging from A1 to D4 [42]. Omnichroma resin was developed with smart color technology and uses the structural color concept, wherein the material itself weakens or amplifies specific wavelengths of light to blend with tooth color, unlike other composite resin systems that add red and yellow pigments to color the material [44].

One of the most crucial aesthetic factors in dentistry is color. The color of composite resins can be influenced by a number of variables, including translucency and color attributes (chroma, hue, and lightness).[4] The layers of natural teeth have irregular morphologies with irregular surface structures [34]. The challenge of appropriately choosing and matching the hue of composite resin restorations is exacerbated by all these aspects. Additionally, utilizing purely instrumental tools to measure tooth color has several drawbacks. Because human teeth are tiny and curved, a significant portion of the light that contacts the tooth surface is lost, which can result in inaccurate color measurements. One of the drawbacks of devices like dental spectrophotometers is this. As a result, although they shouldn't be replaced, these devices are advised as tools for the visual evaluation of color matching. The most popular technique for evaluating color in clinical dentistry practice is visual assessment. [9]

Some studies have already evaluated the *in-vitro* color matching or color-setting potential of these single-shade resins and obtained positive results (acceptable color matching) by making composite resin specimens.[42] In a study using extracted human incisor teeth, Kobayashi *et al*. found that single-tone composite resins demonstrated good color adaptation. [52] Forty human incisors were removed from four single-tone composite resins (Omnichroma, Charisma Diamond One, Vittra Unique, and Essentia Universal), and Altınışık and Özyurt assessed the visual (CAP-V) and instrumental (CAP-I) color-matching potential in each of the samples. All of the samples had positive color-setting potential results. For acrylic denture teeth, other *in-vitro* research have produced unsatisfactory color matching as a negative outcome. [53] Nagi and Moharam evaluated the Omnichroma single-tone resin color matching in patients with class V and/or class III carious lesions and found an unsatisfactory color matching, or a negative outcome. [54]

However, no studies have evaluated the color matching of these single-shade resins by comparing them to a multishade composite resin in extracted human teeth. The aim of the present study is to instrumentally and visually evaluate the color correspondence of two single-shade composite resins in extracted human teeth, compared to a multishade composite resin.

In the present study the color matching of two universal (single shade materials) i.e Omnichroma (OC) and charisma Topaz ONE were not significantly different from each other with almost 80% of the sample showing excellent match (No difference present between the tooth structure and restorative material).

The findings are in agreement with the study conducted by Sanchez *et al* who evaluated the ability of five composites (Omnichroma, Filtek Supreme Ultra, TPH Spectra, Herculite Ultra, and TetricEvoCeram [TE]) to alter color both visually and instrumentally throughout the 16 VITA traditional A1-D4 hues. Compared to the other materials that had been created for certain hues, they discovered that Omnichroma, a single-shade material, had a more favorable potential for color correction. This meant that there was less of a color contrast between Omnichroma and the surrounding tooth structure. [54]

Erika Thaís Cruz da Silva conducted a study to assess the color relationship between two single-shade and multi-shade composite resins in extracted human teeth both visually and instrumentally. The labial surfaces of undamaged upper central incisors and lower and/or upper molars were chosen. 77.49% of the teeth in the visual evaluation, irrespective of the assessment group, fell into the acceptable color match classification, with the closest match having the highest value. [48]

Rasha M. Abdelraouf *et al* found similar results when they evaluated the color-matching and blending-effect of universal shade bulk-fill-resin-composite in resin-composite-models and natural teeth. The universal shade composite fillings showed close color-matching in the composite-models despite their great color variation (shades A1, A2, A3, A3.5, and A4). The satisfactory colour-matching of the universal shade composite might be attributed to its high translucency reflecting the shade of the surrounding walls, even with different shades and translucency. Paravina *et al*. too concluded that the Blending effect increased with increasing the translucency. [36]

In the present study the shade matching of Charisma Diamond was found to be best with highest number of samples excellent and good results These results are in accordance with the results of Surelee Chavan *et al* who conducted an *in-vitro* study to evaluate and compare the shade matching of single, group and multi-shade composite material in acrylic teeth at two depths of preparation, using spectrophotometry. [55] The results are similarto a study conducted by de Abreu *et al*. and Al Hamdan *et al*. showed that multi-shade composites presented better color matching ability than the single-shade composite. [56] A study conducted by Mohd Samad *et al* conducted an *in-vitro* evaluation of color matching ability of single shade composite resins with multi shade resin composite resins placed at different cavity depths in different shades teeth (S1, S2, S3). [56]

These single shade composites has a special quality that stems from "smart chromatic technology." By regulating the size of its filler particles, it can capture the structural color of its surrounds. It is free of additional dyes or pigments, and the fillers produce a reddish-yellow structure that blends in with the surrounding tooth color. The wavelength of light that reaches our eyes is known as color. [57]

In comparison to single-shaded composite resins, the study's findings demonstrated that multi-shaded resin composites typically produced the best outcomes with three different tooth tints. This was explained by the different optical behavior of the restoration in the tooth arch's anterior or posterior half. The translucency of anterior restorations may have been affected by the dark background of the oral cavity, leading in restorations that seemed gray.

A study conducted by Erika Thaís Cruz da Silva *et al* which showed that the color matching of multi shade composite resin is inferior to the single shade composite resins. [48] The findings are also in contrast to the findings of Zulekha *et al* who found the color matching ability of single shade composite was comparable to multi-shade composite, [58] Similarly, Durand *et al*. and Pereira Sanchez *et al*. concluded that the color adjustment potential of Omnichroma was significantly higher than that of the commonly utilized multi-shade resin composites. The capacity of this unique esthetic composite resin to match shades may have been partly attributed to the evenly sized and shaped supra-nano-filled particles. [54,59]

The polychromatic stratification and layering techniques are designed to replicate the different chroma levels found in repaired teeth. The direct creation of superior "esthetic" restorations is made possible by this technology. By lowering the C-factor, these methods lessen the stress caused by polymerization shrinkage that occurs during light polymerization. Dentists can directly create "esthetic" posterior composite restorations by using dentin, enamel, and effect shades to replicate tooth colors in conjunction with incremental implantation procedures and polychromatic stratification. In the end, they provide composite restorations that have a better marginal seal and a decreased chance of developing recurrent caries. The longer chair-side time required, and the lengthy learning curve associated with building up each cusp individually while reproducing tooth color are the drawbacks. [51]

The present study has limitations because it was an *in-vitro* study in which extracted human teeth were used. The results presented in this study may be influenced by several factors associated with both tooth structure and the evaluated composite resin. Variables such as the evaluation time, cavity type, cavity depth, evaluation methods (instrumental and/or visual), brand of single-shade composite resin tested, color of material, type of specimen/sampling unit evaluated, and even brand commercial use of the composite resin used in the control group may influence studies of this type. The sizes of the cavities made in this study were the same for all restorations; however, it may be interesting to conduct a similar study, wherein the cavity sizes of human teeth are varied. In addition, the properties of single-shade composite resins, such as color stability in human teeth and translucency, among other optical properties, should also be evaluated in future studies. Clinical studies could be performed to confirm the results of this *in-vitro* study.

CONCLUSION

CONCLUSION

Variations in tooth color have a significant role in cosmetic dentistry. Determining the color of the teeth is a crucial step in restorative dentistry procedures. Prior to beginning any cosmetic dentistry treatment operations, its therapeutic importance must be considered.

An object's perceived color is determined by the wavelengths that are reflected from it. This selective wavelength reflection in aesthetically pleasing materials, such as ceramics and resin-based composites, is caused by pigments that are a part of their composition. Nonetheless, one-shaded resin-based composites have been generated thanks to inventive technological approaches.

The results of the study showed that multishade resin presented better color correspondence than the single-shade resins. The layering technique used has proven to give superior aesthetic results in terms of shade matching with the existing tooth structure. The different single shade composite resins did not show no difference between each other regarding color matching. It may be better to assess color-matching and blending-effect *in-vivo* rather than *in-vitro* as it is a better simulation of clinical condition. In addition, the properties of single-shade composite resins, such as color stability in human teeth and translucency, among other optical properties, should also be evaluated in future studies.

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ANNEXURES

ANNEXURE 1

BABU BANARASI DAS UNIVERSITY
BBD COLLEGE OF DENTAL SCIENCES, LUCKNOW

BBD UNIVERSITY

BBDCODS/IEC/09/2022 **Dated: 16th September, 2022**

Communication of the Decision of the Xth Institutional Ethics Sub-Committee Meeting

IEC Code: 03

Title of the Project: Comparative Evaluation Of Shade Match Between Single Shade And Universal Shade Restorative Composite: An In Vitro Study.

Principal Investigator: Dr Anuja Kaushik **Department:** Conservative Dentistry and Endodontics

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr Anuja Kaushik,

The Institutional Ethics Sub-Committee meeting comprising following members was held on 15th September, 2022.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry
2.	Dr. Praveen Singh Samant Member	Prof. & Head, Department of Conservative Dentistry & Endodontics
3.	Dr. Jiji George Member	Prof. & Head, Department of Oral Pathology & Microbilogy
4.	Dr. Amrit Tandan Member	Professor, Department of Prosthodontics and Crown & Bridge
5.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopaedics

The submitted documents of the current MDS Project Protocol is exempted for review in the meeting.

Decision: The MDS Protocol is exempted for review by the Institutional Ethics Sub-Committee.

Forwarded by:

Prof. Dr. Puneet Ahuja
Principal
BBD College of Dental Sciences
BBD University, Lucknow

Dr. Lakshmi Bala
Member-Secretary
Institutional Ethics Sub-Committee (IEC)
BBD College of Dental Sciences
BBD University, Lucknow

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

ANNEXURE 2

BABU BANARASI DAS UNIVERSITY

BBD COLLEGE OF DENTAL SCIENCES, LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled "**Comparative Evaluation Of Shade Match Between Single Shade And Universal Shade Restorative Composite: An In Vitro Study**" submitted by **Dr Anuja Kaushik** Postgraduate student in the **Department of Conservative Dentistry and Endodontics** for the Thesis Dissertation as part of MDS Curriculum for the academic year 2021-2024 with the accompanying proforma was reviewed by the Institutional Research Committee in its meeting held on **14th September, 2022** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Dr. Puneet Ahuja
Chairperson

Dr. Mona Sharma
Co-Chairperson

ANNEXURE 3

SAMPLE SIZE CALCULATION

Sample size = 2 SD^2 $(Z_{\alpha/2} + Z_{\beta})^2/d^2$

SD – Standard deviation = From previous studies or pilot study

$Za/2 = Z_{0.05/2} = Z0.025$ = 1.96 (From *Z* table) at type 1 error of 5%

Z□□= $Z_{0.20}$ = 0.84 (From *Z* table) at 80% power

d = effect size = difference between mean values

So now formula will be

Sample size = 2 SD^2 $(1.96+0.84)^2/d^2$

$= 2 (0.18)^2 (1.96+0.84)^2 / (0.2)^2$

= 12.70 ~13

As the sample size calculation formula is for 2 groups.

In our study there are 12 subgroups, so the total sample size will remain 78, which can be averaged to 80.

Dr Manu Sharma

M.D.S. (Public Health Dentisry)

Cert. Biostatistics & Research Methodology

ANNEXURE 4

To,

Date: 28 June 2022

Research Center,

Department of Oral Pathology and Microbiology,

BBDCODS, Lucknow.

Subject: **Permission to do a part of my thesis in Research Centre, ITS Dental College, Greater Noida.**

Respected Ma'am,

With all due respect I, Anuja Kaushik, MDS first year student of the Department of Conservative Dentistry and Endodontics wants to carry out the evaluation part of my thesis in your research centre, ITS Dental College and Hospital, Greater Noida.

My thesis will be on the topic **"comparative evaluation of shade match between single shade and universal shade restorative composite: an *in-vitro* study"**; wherein I will be evaluating the shade match of 96 samples of extracted teeth both pre-operatively and post-operatively.

I will be evaluating the shade of the selected third of the tooth, further restoring it with a restorative material. Further, I will be evaluating the shade match post restorative procedure both visually and with the help of a Spectrophotometer. As the device mentioned is available in the reputed research centre of ITS Dental College, Greater Noida; Kindly allow me conduct this part of my thesis in your reputed institution.

I will be highly grateful.

Thanking You,

Yours Sincerely,

Anuja Kaushik

MDS- I year

Department of Conservative Dentistry and Endodontics

Signature of Co-Guide

Dr. Ananya Rawat

Senior Lecturer

24/06/2022

Signature of Guide

Dr. Atul Jain

Professor

Permitted

Dr. Monica Mehendiratta

Dr. Monica Mehendiratta
Faculty In-charge
Center for Advanced Research (CAR)
Prof and Head Dept of Oral Pathology

29-6-22

Signature of HOD

Dr. Praveen Singh Samant

Professor and Head

Department of Conservative Dentistry and Endodontics

ANNEXURE 5

TABLE 7: Spectrophotometric reading for Incisor Class IV base shade

sample number	tooth	before restoration			vita shade	A1
		L	a	b		
1	Incisor class IV	60.45	6.97	12.44	A2	A1E
2	Incisor class IV	54.8	6.88	13.42	C2	A1E
3	Incisor class IV	61.85	6.07	12.53	B2	A1E
4	Incisor class IV	55.14	7.97	14.55	A3	A1E
5	Incisor class IV	49.2	7.97	16.8	B3	A1E
6	Incisor class IV	60.55	6.97	12.37	A2	A1E
7	Incisor class IV	60.43	6.99	12.37	A2	A1E
8	Incisor class IV	61.37	6.08	12.55	B2	A1E
9	Incisor class IV	59.83	4.24	7.33	B1	A1E
10	Incisor class IV	60.12	6.98	12.46	A2	A1E
11	Incisor class IV	55.65	7.2	11.65	D3	A1E
12	Incisor class IV	60.18	6.98	12.44	A2	A1E
13	Incisor class IV	61.46	6	12.5	B2	A1E
14	Incisor class IV	61.91	6.12	12.55	B2	A1E
15	Incisor class IV	63.44	5	9	A1	A1E
16	Incisor class IV	55.27	7.31	11.75	D3	A1E
17	Incisor class IV	55.62	7.1	11.66	D3	A1E
18	Incisor class IV	60.24	6.95	12.45	A2	A1E
19	Incisor class IV	61.88	6.09	12.53	B2	A1E
20	Incisor class IV	60.47	6.97	12.23	A2	A1E

TABLE 8: Spectrophotometric reading for Incisor Class V base shade

21	Incisor class V	49.03	7.99	16.83	B3	A1F
22	Incisor class V	60.13	6.99	12.46	A2	A1F
23	Incisor class V	61.99	6.05	12.47	B2	A1F
24	Incisor class V	45.99	6.77	12.86	C3	A1F
25	Incisor class V	55	7	11.68	D3	A1F
26	Incisor class V	55.78	6.17	14.42	D4	A1F
27	Incisor class V	60.18	6.95	12.48	A2	A1F
28	Incisor class V	63.44	5.05	9.1	A1	A1F
29	Incisor class V	59.88	4.24	7.3	B1	A1F

30	Incisor class V	56.55	7.69	14.56	A3	A1F
31	Incisor class V	60.55	6.99	12.42	A2	A1F
32	Incisor class V	61.92	6.08	12.5	B2	A1F
33	Incisor class V	49	7.96	14.57	B3	A1F
34	Incisor class V	55.88	5.14	8.82	C1	A1F
35	Incisor class V	55.65	7.2	11.65	D3	A1F
36	Incisor class V	63.44	5.05	9.2	A1	A1F
37	Incisor class V	60.55	6.99	12.47	A2	A1F
38	Incisor class V	63.44	5.04	9.17	A1	A1F
39	Incisor class V	56.1	7.94	14.55	A3	A1F
40	Incisor class V	54.83	6.86	13.4	C2	A1F

TABLE 9: Spectrophotometric reading for Molar Class I compound base shade

41	Molar class I compound	61.91	6.05	12.51	B2	A2E
42	Molar class I compound	54.8	6.88	13.43	C2	A2E
43	Molar class I compound	54.8	6.88	13.42	C2	A1E
44	Molar class I compound	60.53	7	12.48	A2	A2E
45	Molar class I compound	60.55	6.95	12.44	A2	A2E
46	Molar class I compound	61.89	6.05	12.53	B2	A2E
47	Molar class I compound	63.44	5.1	9.12	A1	A2E
48	Molar class I compound	46.28	6.77	12.85	C3	A2E
49	Molar class I compound	56.15	7.95	14.55	A3	A2E
50	Molar class I compound	60.54	6.95	12.45	A2	A2E
51	Molar class I compound	63.46	5.05	9.11	A1	A2E
52	Molar class I compound	59.51	5.6	8.6	D2	A2E
53	Molar class I compound	60.24	6.99	12.46	A2	A2E
54	Molar class I compound	61.92	6.11	12.53	B2	A2E
55	Molar class I compound	55.84	7.32	11.69	D3	A2E
56	Molar class I compound	55.38	7.45	11.37	D3	A2E
57	Molar class I compound	56.16	7.95	14.58	A3	A2E
58	Molar class I compound	60.53	6.97	12.45	A2	A2E
59	Molar class I compound	49.21	7.96	16.8	B3	A2E
60	Molar class I compound	61.91	6.97	12.45	B2	A2E

TABLE 10: Spectrophotometric reading for Molar Class V compound base shade

61	Molar class V	61.9	6.97	12.45	B2	A2F
62	Molar class V	59.84	5.12	8.58	D2	A2F
63	Molar class V	60.55	6.99	12.44	A2	A2F
64	Molar class V	54.85	6.84	13.44	C2	A2F

65	Molar class V	61.92	6.97	12.46	B2	A2F
66	Molar class V	61.9	6.99	12.44	B2	A2F
67	Molar class V	61.9	6.97	12.52	B2	A2F
68	Molar class V	59.88	4.22	7.32	B1	A2F
69	Molar class V	63.44	5.1	9.1	A1	A2F
70	Molar class V	60.22	6.94	12.45	A2	A2F
71	Molar class V	63.21	5.44	9.12	A1	A2F
72	Molar class V	54.82	6.84	13.41	C2	A2F
73	Molar class V	56.12	7.96	14.98	A3	A2F
74	Molar class V	61.89	6.07	12.55	B2	A2F
75	Molar class V	60.45	6.94	12.46	A2	A2F
76	Molar class V	61.88	6.06	12.52	B2	A2F
77	Molar class V	46.29	6.76	12.88	C3	A2F
78	Molar class V	61.92	6.05	12.53	B2	A2F
79	Molar class V	60.55	6.96	12.47	A2	A2F
80	Molar class V	60.54	6.96	12.44	A2	A2F

TABLE 11: Spectrophotometric reading for Incisor Class IV after Omnichroma restoration

sample number	tooth	after Omnichroma			vita shade	result	B1
		L	a	b			
1	Incisor class IV	61.91	6.11	12.57	B2	discrepancy	B1E
2	Incisor class IV	54.83	6.82	13.46	C2	good	B1E
3	Incisor class IV	61.85	6.05	12.53	B2	good	B1E
4	Incisor class IV	55.11	7.97	14.58	A3	good	B1E
5	Incisor class IV	49.23	7.92	16.84	B3	good	B1E
6	Incisor class IV	60.51	6.94	12.4	A2	good	B1E
7	Incisor class IV	60.56	6.93	12.37	A2	good	B1E
8	Incisor class IV	61.95	6.08	12.59	B2	good	B1E
9	Incisor class IV	61.93	6.05	12.51	B2	discrepancy	B1E
10	Incisor class IV	60.16	6.98	12.43	A2	good	B1E
11	Incisor class IV	55	7	11.68	D3	good	B1E
12	Incisor class IV	60.94	6.98	12.35	A2	good	B1E
13	Incisor class IV	61.83	6.15	12.44	B2	good	B1E
14	Incisor class IV	61.92	6.12	12.59	B2	good	B1E
15	Incisor class IV	59.88	4.23	7.36	B1	discrepancy	B1E
16	Incisor class IV	55.71	7.09	11.69	D3	good	B1E
17	Incisor class IV	55.53	6.11	14.47	D4	discrepancy	B1E

18	Incisor class IV	60.27	6.95	12.49	A2	good	B1E
19	Incisor class IV	61.83	6.09	12.58	B2	good	B1E
20	Incisor class IV	60.44	6.92	12.23	A2	good	B1E

TABLE 12: Spectrophotometric reading for Incisor Class V after Omnichroma restoration

21	Incisor class V	49.09	7.9	16.8	B3	good	B1F
22	Incisor class V	60.11	6.95	12.44	A2	good	B1F
23	Incisor class V	59.43	5.54	8.56	D2	discrepancy	B1F
24	Incisor class V	55.62	7.15	11.65	D3	discrepancy	B1F
25	Incisor class V	55.16	7.54	11.34	D3	good	B1F
26	Incisor class V	55.71	6.11	14.42	D4	good	B1F
27	Incisor class V	60.14	6.24	12.48	A2	good	B1F
28	Incisor class V	63.63	5.09	9.1	A1	good	B1F
29	Incisor class V	59.82	4.37	7.3	B1	good	B1F
30	Incisor class V	56.42	7.66	14.56	A3	good	B1F
31	Incisor class V	60.59	6.97	12.42	A2	good	B1F
32	Incisor class V	61.73	6.12	12.5	B2	good	B1F
33	Incisor class V	49.17	7.08	14.57	B3	good	B1F
34	Incisor class V	55.84	5.16	8.82	C1	good	B1F
35	Incisor class V	49.21	7.93	16.3	B3	discrepancy	B1F
36	Incisor class V	63.44	5.08	9.16	A1	good	B1F
37	Incisor class V	60.58	6.93	12.44	A2	good	B1F
38	Incisor class V	63.49	5	9.14	A1	good	B1F
39	Incisor class V	54.85	6.86	13.42	C2	discrepancy	B1F
40	Incisor class V	60.58	6.85	12.44	A2	discrepancy	B1F

TABLE 13: Spectrophotometric reading for Molar Class I compound after Omnichroma restoration

41	Molar class I compound	61.77	6.08	12.55	B2	good	B2E
42	Molar class I compound	54.88	6.82	13.47	C2	good	B2E
43	Molar class I compound	54.83	6.82	13.46	C2	good	B1E
44	Molar class I compound	60.57	7.16	12.33	A2	good	B2E
45	Molar class I compound	54.86	6.88	13.44	C2	discrepancy	B2E
46	Molar class I compound	61.84	6.06	12.55	B2	good	B2E
47	Molar class I compound	63.49	5.16	9.15	A1	good	B2E
48	Molar class I compound	46.44	6.74	12.88	C3	good	B2E
49	Molar class I compound	56.19	7.83	14.47	A3	good	B2E
50	Molar class I compound	60.83	6.77	12.5	A2	good	B2E

51	Molar class I compound	59.88	4.23	7.34	B1	discrepancy	B2E
52	Molar class I compound	59.47	5.6	8.55	D2	good	B2E
53	Molar class I compound	60.22	6.99	12.43	A2	good	B2E
54	Molar class I compound	61.89	6.1	12.52	B2	good	B2E
55	Molar class I compound	55.65	7.2	11.65	D3	good	B2E
56	Molar class I compound	55.67	7.34	11.76	D3	good	B2E
57	Molar class I compound	56.11	7.89	14.58	A3	good	B2E
58	Molar class I compound	60.58	6.94	12.44	A2	good	B2E
59	Molar class I compound	50.01	8.14	18.31	B4	discrepancy	B2E
60	Molar class I compound	61.91	6.95	12.41	B2	good	B2E

TABLE 14: Spectrophotometric reading for Molar Class V after Omnichroma restoration

61	Molar class V	46.25	6.66	12.84	C3	discrepancy	B2F
62	Molar class V	59.53	5.15	8.73	D2	good	B2F
63	Molar class V	60.58	6.94	12.46	A2	good	B2F
64	Molar class V	59.88	4.22	7.35	B1	discrepancy	B2F
65	Molar class V	61.92	6.97	12.46	B2	good	B2F
66	Molar class V	61.9	6.99	12.44	B2	good	B2F
67	Molar class V	60.54	6.91	12.48	A2	discrepancy	B2F
68	Molar class V	61.88	6.11	12.52	B2	discrepancy	B2F
69	Molar class V	63.44	5.1	9.1	A1	good	B2F
70	Molar class V	63.43	5	9.15	A1	discrepancy	B2F
71	Molar class V	63.21	5.44	9.12	A1	good	B2F
72	Molar class V	54.82	6.84	13.41	C2	good	B2F
73	Molar class V	48.94	8.44	15.73	A3.5	discrepancy	B2F
74	Molar class V	61.89	6.01	12.53	B2	good	B2F
75	Molar class V	60.43	6.94	12.46	A2	good	B2F
76	Molar class V	61.75	6.05	12.55	B2	good	B2F
77	Molar class V	63.43	5.1	9.12	A1	discrepancy	B2F
78	Molar class V	61.95	6.07	12.55	B2	good	B2F
79	Molar class V	60.59	6.66	12.43	A2	good	B2F
80	Molar class V	60.54	6.96	12.41	A2	good	B2F

TABLE 15: Spectrophotometric reading for Incisor Class IV after Charisma Topaz ONE restoration

sample number	tooth	after Charisma Topaz one			vita shade	result	
		L	a	b			
1	Incisor class IV	60.48	6.99	12.47	A2	good	C1
2	Incisor class IV	54.84	6.88	13.49	C2	good	C1
3	Incisor class IV	61.91	6.04	12.57	B2	good	C1
4	Incisor class IV	55.17	7.94	14.52	A3	good	C1
5	Incisor class IV	50.04	8.11	18.32	B4	discrepancy	C1
6	Incisor class IV	60.55	6.88	12.41	A2	good	C1
7	Incisor class IV	60.58	6.95	12.38	A2	good	C1
8	Incisor class IV	61.97	6.05	12.59	B2	good	C1
9	Incisor class IV	63.44	5.05	9.13	A1	discrepancy	C1
10	Incisor class IV	60.14	6.99	12.49	A2	good	C1
11	Incisor class IV	54.81	6	13.42	C2	discrepancy	C1
12	Incisor class IV	60.11	6.98	12.33	A2	good	C1
13	Incisor class IV	61.92	6.07	12.56	B2	good	C1
14	Incisor class IV	54.82	6.86	13.43	C2	discrepancy	C1
15	Incisor class IV	59.88	4.23	7.36	B1	discrepancy	C1
16	Incisor class IV	55.65	7.2	11.65	D3	good	C1
17	Incisor class IV	55.55	6.17	14.41	D4	discrepancy	C1
18	Incisor class IV	60.49	6.88	12.44	A2	good	C1
19	Incisor class IV	61.88	6.11	12.52	B2	good	C1
20	Incisor class IV	60.54	6.92	12.43	A2	good	C1

TABLE 16: Spectrophotometric reading for Incisor Class V after Charisma Topaz ONE restoration

21	Incisor class V	34.91	7.22	12.86	C4	discrepancy	C2
22	Incisor class V	60.58	6.85	12.44	A2	good	C2
23	Incisor class V	61.95	6.11	12.49	B2	good	C2
24	Incisor class V	46.28	6.74	12.88	C3	good	C2
25	Incisor class V	55.62	7.1	11.66	D3	good	C2
26	Incisor class V	46.28	6.76	12.85	C3	discrepancy	C2
27	Incisor class V	61.97	6.09	12.58	B2	discrepancy	C2
28	Incisor class V	63.36	5.08	9.16	A1	good	C2
29	Incisor class V	55.86	5.13	8.83	C1	discrepancy	C2
30	Incisor class V	56.15	7.91	14.55	A3	good	C2
31	Incisor class V	56.15	7.96	14.55	A3	discrepancy	C2
32	Incisor class V	61.94	6.11	12.56	B2	good	C2
33	Incisor class V	49.26	7.96	14.47	B3	good	C2

34	Incisor class V	55.84	5.18	8.79	C1	good	C2
35	Incisor class V	49.23	7.93	16.3	B3	discrepancy	C2
36	Incisor class V	59.85	4.22	7.36	B1	discrepancy	C2
37	Incisor class V	60.58	6.93	12.44	A2	good	C2
38	Incisor class V	63.48	5.07	9.15	A1	good	C2
39	Incisor class V	54.87	6.83	13.44	C2	discrepancy	C2
40	Incisor class V	46.29	6.76	12.88	C3	discrepancy	C2

TABLE 17: Spectrophotometric reading for Molar Class I compound after Charisma Topaz ONE restoration

41	Molar class I compound	61.99	6.05	12.47	B2	good	D1
42	Molar class I compound	54.83	6.84	13.48	C2	good	D1
43	Molar class I compound	54.84	6.88	13.49	C2	good	C1
44	Molar class I compound	60.37	6.99	12.44	A2	good	D1
45	Molar class I compound	60.77	6.94	12.48	A2	good	D1
46	Molar class I compound	61.93	6.07	12.57	B2	good	D1
47	Molar class I compound	59.88	4.23	7.41	B1	discrepancy	D1
48	Molar class I compound	46.25	6.73	12.83	C3	good	D1
49	Molar class I compound	56.17	7.98	14.58	A3	good	D1
50	Molar class I compound	60.78	6.94	12.47	A2	good	D1
51	Molar class I compound	59.85	4.22	7.36	B1	discrepancy	D1
52	Molar class I compound	59.51	5.58	8.57	D2	good	D1
53	Molar class I compound	60.27	6.92	12.47	A2	good	D1
54	Molar class I compound	61.94	6.15	12.56	B2	good	D1
55	Molar class I compound	50.04	8.15	18.31	B4	discrepancy	D1
56	Molar class I compound	55.11	7.16	11.58	D3	good	D1
57	Molar class I compound	56.14	7.94	14.52	A3	good	D1
58	Molar class I compound	60.49	6.96	12.43	A2	good	D1
59	Molar class I compound	49.34	7.93	16.88	B3	good	D1
60	Molar class I compound	54.82	6.86	13.44	C2	discrepancy	D1

TABLE 18: Spectrophotometric reading for Molar Class V after Charisma Topaz ONE restoration

61	Molar class V	61.79	6.86	12.47	B2	good	D2
62	Molar class V	59.32	5.17	8.58	D2	good	D2
63	Molar class V	61.9	6.97	12.45	B2	discrepancy	D2
64	Molar class V	54.83	6.82	13.46	C2	good	D2
65	Molar class V	60.54	6.97	12.44	A2	discrepancy	D2
66	Molar class V	61.86	6.96	12.42	B2	good	D2

67	Molar class V	54.85	6.82	13.44	C2	discrepancy	D2
68	Molar class V	59.83	4.28	7.36	B1	good	D2
69	Molar class V	59.88	4.22	7.35	B1	discrepancy	D2
70	Molar class V	60.28	6.94	12.44	A2	good	D2
71	Molar class V	59.83	4.23	7.77	B1	discrepancy	D2
72	Molar class V	54.79	6.81	13.42	C2	good	D2
73	Molar class V	56.17	7.93	14.95	A3	good	D2
74	Molar class V	61.68	6.06	12.53	B2	good	D2
75	Molar class V	61.44	6.07	12.53	B2	discrepancy	D2
76	Molar class V	61.83	6.2	12.54	B2	good	D2
77	Molar class V	46.29	6.76	12.88	C3	good	D2
78	Molar class V	61.92	6.05	12.54	B2	good	D2
79	Molar class V	61.47	6	7.73	B2	discrepancy	D2
80	Molar class V	60.57	6.99	12.43	A2	good	D2

TABLE 19: Spectrophotometric reading for Incisor Class IV after Charisma Diamond restoration

sample number	tooth	after Charisma diamond				result
		L	a	b	vita shade	
1	Incisor class IV	60.54	6.92	12.48	A2	good
2	Incisor class IV	54.85	6.84	13.44	C2	good
3	Incisor class IV	61.89	6.06	12.58	B2	good
4	Incisor class IV	56.1	7.94	14.55	A3	good
5	Incisor class IV	49.27	7.99	16.85	B3	good
6	Incisor class IV	60.54	6.99	12.31	A2	good
7	Incisor class IV	60.64	6.98	12.33	A2	good
8	Incisor class IV	61.88	6.11	12.54	B2	good
9	Incisor class IV	59.88	4.23	7.36	B1	good
10	Incisor class IV	60.14	6.24	12.48	A2	good
11	Incisor class IV	55.62	7.1	11.66	D3	good
12	Incisor class IV	60.88	6.87	12.47	A2	good
13	Incisor class IV	61.94	6.11	12.51	B2	good
14	Incisor class IV	61.93	6.07	12.49	B2	good
15	Incisor class IV	63.63	5.09	9.1	A1	good
16	Incisor class IV	55.61	7.17	11.62	D3	good
17	Incisor class IV	55.65	7.2	11.65	D3	good
18	Incisor class IV	60.33	6.91	12.49	A2	good
19	Incisor class IV	61.91	6.11	12.57	B2	good

20	Incisor class IV	61.97	6.09	12.58	B2	discrepancy

TABLE20: Spectrophotometric reading for Incisor Class V after Charisma Diamond restoration

21	Incisor class V	49.27	7.93	16.85	B3	good
22	Incisor class V	60.17	6.94	12.49	A2	good
23	Incisor class V	61.95	6.08	12.59	B2	good
24	Incisor class V	46.25	6.73	12.83	C3	good
25	Incisor class V	55.65	7.2	11.65	D3	good
26	Incisor class V	55	7	11.68	D3	good
27	Incisor class V	60.77	6.94	12.48	A2	good
28	Incisor class V	63.55	5.11	9.14	A1	good
29	Incisor class V	59.85	4.31	7.66	B1	good
30	Incisor class V	54.81	6.86	13.41	C2	discrepancy
31	Incisor class V	60.51	6.94	12.48	A2	good
32	Incisor class V	61.98	6.11	12.49	B2	good
33	Incisor class V	49.19	7.99	14.51	B3	good
34	Incisor class V	59.83	4.22	7.34	B1	discrepancy
35	Incisor class V	55.62	7.1	11.66	D3	good
36	Incisor class V	63.81	5.1	9.14	A1	good
37	Incisor class V	60.51	6.91	12.51	A2	good
38	Incisor class V	59.81	4.28	7.27	B1	discrepancy
39	Incisor class V	56.16	7.91	14.59	A3	good
40	Incisor class V	54.81	6.82	13.44	C2	good

TABLE 21: Spectrophotometric reading for Molar Class I compound after Charisma Diamond restoration

41	Molar class I compound	60.56	6.94	12.44	A2	discrepancy
42	Molar class I compound	54.79	6.81	13.41	C2	good
43	Molar class I compound	54.85	6.84	13.44	C2	good
44	Molar class I compound	60.58	6.95	12.44	A2	good
45	Molar class I compound	60.54	6.91	12.48	A2	good
46	Molar class I compound	61.88	6.04	12.56	B2	good
47	Molar class I compound	63.36	5.08	9.16	A1	good
48	Molar class I compound	54.85	6.88	13.43	C2	discrepancy
49	Molar class I compound	56.18	7.93	14.49	A3	good
50	Molar class I compound	60.58	6.89	12.44	A2	good
51	Molar class I compound	63.41	5.11	9.09	A1	good
52	Molar class I compound	54.86	6.88	13.44	C2	discrepancy

53	Molar class I compound	60.31	6.96	12.48	A2	good
54	Molar class I compound	60.54	6.97	12.44	A2	discrepancy
55	Molar class I compound	55.8	7.13	11.66	D3	good
56	Molar class I compound	55.62	7.11	11.52	D3	good
57	Molar class I compound	48.92	8.44	15.72	A3.5	discrepancy
58	Molar class I compound	60.44	6.92	12.48	A2	good
59	Molar class I compound	49.31	7.97	16.83	B3	good
60	Molar class I compound	61.88	6.99	12.49	B2	good

TABLE 22: Spectrophotometric reading for Molar Class V after Charisma Diamond restoration

61	Molar class V	61.79	6.93	12.41	B2	good
62	Molar class V	61.99	6.1	12.55	B2	discrepancy
63	Molar class V	60.22	6.99	12.43	A2	good
64	Molar class V	54.83	6.84	13.48	C2	good
65	Molar class V	61.77	6.99	12.51	B2	good
66	Molar class V	61.89	6.91	12.48	B2	good
67	Molar class V	61.95	6.93	12.56	B2	good
68	Molar class V	59.85	4.28	7.41	B1	good
69	Molar class V	63.36	5.08	9.16	A1	good
70	Molar class V	60.24	6.99	12.46	A2	good
71	Molar class V	63.32	5.48	9.32	A1	good
72	Molar class V	54.88	6.78	13.48	C2	good
73	Molar class V	56.63	7.99	14.92	A3	good
74	Molar class V	61.79	6.86	12.47	B2	good
75	Molar class V	60.51	6.98	12.44	A2	good
76	Molar class V	61.88	6.09	12.53	B2	good
77	Molar class V	46.44	6.74	12.88	C3	good
78	Molar class V	61.89	6.04	12.55	B2	good
79	Molar class V	60.58	6.99	12.49	A2	good
80	Molar class V	61.94	6.07	12.53	B2	discrepancy

TABLE 23: Visual gradings for samples

sample number	tooth	vita shade	A1	Omnichroma	B1	Charisma Topaz one		Charisma smart
1	Incisor class IV	A2	A1E	III	B1E	I	C1	I
2	Incisor class IV	C2	A1E	II	B1E	I	C1	I
3	Incisor class IV	B2	A1E	I	B1E	I	C1	I

4	Incisor class IV	A3	A1E	I	B1E	I	C1	I
5	Incisor class IV	B3	A1E	I	B1E	III	C1	I
6	Incisor class IV	A2	A1E	I	B1E	I	C1	I
7	Incisor class IV	A2	A1E	I	B1E	I	C1	I
8	Incisor class IV	B2	A1E	I	B1E	I	C1	I
9	Incisor class IV	B1	A1E	III	B1E	III	C1	II
10	Incisor class IV	A2	A1E	I	B1E	I	C1	I
11	Incisor class IV	D2	A1E	I	B1E	I	C1	I
12	Incisor class IV	A2	A1E	I	B1E	I	C1	I
13	Incisor class IV	B2	A1E	I	B1E	I	C1	I
14	Incisor class IV	B2	A1E	I	B1E	II	C1	I
15	Incisor class IV	A1	A1E	II	B1E	III	C1	III
16	Incisor class IV	D2	A1E	I	B1E	I	C1	I
17	Incisor class IV	D3	A1E	I	B1E	II	C1	II
18	Incisor class IV	A2	A1E	I	B1E	I	C1	I
19	Incisor class IV	B2	A1E	I	B1E	I	C1	I
20	Incisor class IV	A2	A1E	I	B1E	I	C1	I
21	Incisor class V	B3	A1F	I	B1F	I	C2	I
22	Incisor class V	A2	A1F	I	B1F	I	C2	I
23	Incisor class V	B2	A1F	III	B1F	I	C2	II
24	Incisor class V	C3	A1F	III	B1F	I	C2	III
25	Incisor class V	D2	A1F	III	B1F	I	C2	I
26	Incisor class V	D4	A1F	I	B1F	I	C2	II
27	Incisor class V	A2	A1F	I	B1F	I	C2	II
28	Incisor class V	A1	A1F	I	B1F	I	C2	I
29	Incisor class V	B1	A1F	I	B1F	II	C2	I
30	Incisor class V	A3	A1F	I	B1F	I	C2	II
31	Incisor class V	A2	A1F	I	B1F	II	C2	I
32	Incisor class V	B2	A1F	I	B1F	I	C2	I
33	Incisor class V	B3	A1F	I	B1F	I	C2	I
34	Incisor class V	C1	A1F	I	B1F	I	C2	II
35	Incisor class V	D3	A1F	III	B1F	III	C2	I
36	Incisor class V	A1	A1F	I	B1F	I	C2	I
37	Incisor class V	A2	A1F	I	B1F	I	C2	I
38	Incisor class V	A1	A1F	I	B1F	I	C2	I
39	Incisor class V	A3	A1F	II	B1F	II	C2	I
40	Incisor class V	C2	A1F	I	B1F	III	C2	I
41	Molar class I compound	B2	A2E	I	B2E	II	D1	II
42	Molar class I compound	C2	A2E	I	B2E	I	D1	I

43	Molar class I compound	C1	A2E	I	B2E	I	D1	I
44	Molar class I compound	A2	A2E	I	B2E	I	D1	I
45	Molar class I compound	A2	A2E	II	B2E	I	D1	I
46	Molar class I compound	B2	A2E	II	B2E	I	D1	I
47	Molar class I compound	A1	A2E	II	B2E	III	D1	I
48	Molar class I compound	C3	A2E	I	B2E	I	D1	I
49	Molar class I compound	A3	A2E	I	B2E	I	D1	I
50	Molar class I compound	A2	A2E	I	B2E	I	D1	I
51	Molar class I compound	A1	A2E	I	B2E	I	D1	I
52	Molar class I compound	D2	A2E	I	B2E	I	D1	II
53	Molar class I compound	A2	A2E	I	B2E	I	D1	I
54	Molar class I compound	B2	A2E	I	B2E	I	D1	II
55	Molar class I compound	D4	A2E	I	B2E	II	D1	I
56	Molar class I compound	D2	A2E	I	B2E	I	D1	I
57	Molar class I compound	A3	A2E	I	B2E	I	D1	II
58	Molar class I compound	A2	A2E	I	B2E	I	D1	I
59	Molar class I compound	B3	A2E	I	B2E	I	D1	I
60	Molar class I compound	B2	A2E	I	B2E	II	D1	I
61	Molar class V	B2	A2F	II	B2F	I	D2	I
62	Molar class V	D2	A2F	I	B2F	I	D2	I
63	Molar class V	A2	A2F	I	B2F	I	D2	I
64	Molar class V	C1	A2F	II	B2F	I	D2	I
65	Molar class V	B2	A2F	I	B2F	I	D2	I
66	Molar class V	B2	A2F	I	B2F	III	D2	I
67	Molar class V	B2	A2F	I	B2F	II	D2	I
68	Molar class V	B1	A2F	I	B2F	I	D2	I
69	Molar class V	A1	A2F	I	B2F	I	D2	II
70	Molar class V	A2	A2F	II	B2F	I	D2	I

71	Molar class V	A1	A2F	I	B2F	III	D2	I
72	Molar class V	C2	A2F	I	B2F	I	D2	I
73	Molar class V	A3	A2F	II	B2F	I	D2	I
74	Molar class V	B2	A2F	I	B2F	I	D2	I
75	Molar class V	A2	A2F	I	B2F	II	D2	I
76	Molar class V	B2	A2F	I	B2F	I	D2	II
77	Molar class V	C1	A2F	III	B2F	I	D2	I
78	Molar class V	B2	A2F	I	B2F	I	D2	I
79	Molar class V	A2	A2F	I	B2F	I	D2	I
80	Molar class V	A2	A2F	I	B2F	I	D2	II

TABLE 24: Spectrophotometric readings for VITAPAN Classical shade guide

VITA SHADE	L	A	B
A1	63.46	5.05	9.11
A2	60.55	6.99	12.46
A3	56.16	7.96	14.58
A3.5	48.94	8.49	15.7
A4	43.05	8.34	14.94
B1	59.85	4.24	7.34
B2	61.9	6.09	12.55
B3	49.28	7.97	16.83
B4	50.02	8.17	18.33
C1	55.87	5.15	8.81
C2	54.83	6.87	13.4
C3	46.29	6.78	12.88
C4	34.92	7.23	12.87
D2	59.41	5.59	8.59
D3	55.65	7.19	11.69
D4	55.57	6.18	14.4

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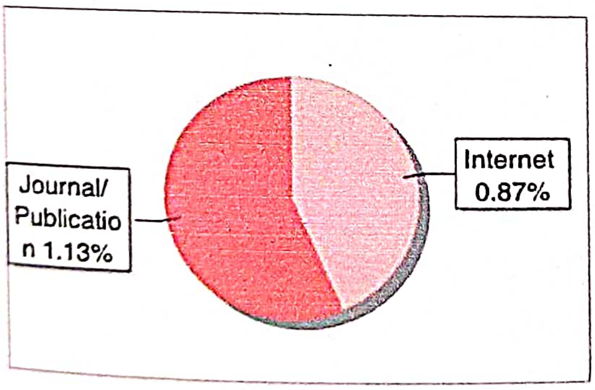

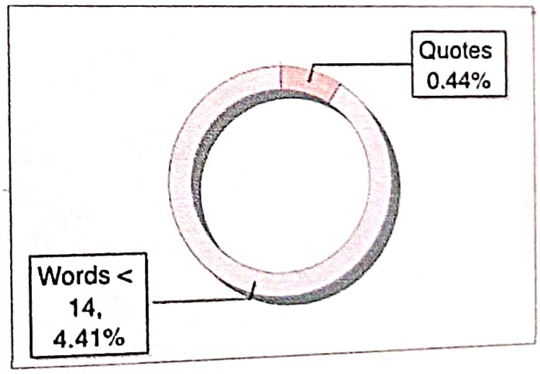

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