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Shade match, marginal adaptation and patient satisfaction: polymer infiltrated ceramic versus lithium disilicate glass ceramic anterior laminate veneers (Randomized Clinical Trial)

Correspondência de cor, adaptação marginal e satisfação do paciente: laminados de cerâmica infiltrada por polímero versus cerâmica vítrea de dissilicato de lítio (Ensaio Clínico Randomizado)

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Abstract

Objective: To evaluate the shade match, marginal adaptation and patient satisfaction of VITA ENAMIC multiColor anterior laminate veneers and compare it to that of IPS e.max CAD. **Material and Methods:** A total of twenty-two laminate veneers were fabricated from IPS e.max CAD and VITA ENAMIC multiColor in the anterior zone, eleven veneers for each group. The patients were randomly divided into two equal groups according to the restorative material. Group EX (control group) eleven IPS e.max CAD veneers and Group EMC (intervention group) eleven VITA ENAMIC multiColor veneers. Shade match and marginal adaptation was assessed using modified USPHS criteria and patient satisfaction was evaluated through visual analogue scale (VAS), immediately after cementation. Data were analyzed using CHI- square test. P 0.05 was considered statistically significant. **Results:** The results showed that there was no statistically significant difference between the two groups in terms of shade matching, marginal adaptation and patient satisfaction. **Conclusion:** IPS e.max CAD and VITA ENAMIC multiColor veneers provided a successful clinical performance in terms of shade match, marginal adaptation and patient satisfaction.

KEYWORDS

CAD-CAM; Ceramics; Color perception; Hybrid; Lithium disilicate.

RESUMO

Objetivo: Avaliar a correspondência de cor, adaptação marginal e satisfação de pacientes, de laminados cerâmicos anteriores VITA ENAMIC multiColor e compará-los com o IPS e.max CAD. **Material e Métodos:** Um total de vinte e dois laminados cerâmicos foram fabricados a partir do IPS e.max CAD e VITA ENAMIC multiColor na zona anterior, onze laminados para cada grupo. Os pacientes foram divididos aleatoriamente em dois grupos iguais de acordo com o material restaurador. Grupo EX (grupo controle) onze laminados IPS e.max CAD e Grupo EMC (grupo intervenção) onze laminados VITA ENAMIC multiColor. A correspondência de cor e a adaptação marginal foram avaliadas usando os critérios modificados do USPHS e a satisfação do paciente foi avaliada através da escala analógica visual (VAS), imediatamente após a cimentação. Os dados foram analisados usando o teste de qui-quadrado. $P < 0,05$ foi considerado estatisticamente significante. **Resultados:** Os resultados mostraram que não houve diferença estatisticamente significante entre os dois grupos em termos de correspondência de cor, adaptação marginal e satisfação do paciente. **Conclusão:** Os laminados cerâmicos IPS e.max CAD e VITA ENAMIC multiColor apresentaram um desempenho clínico bem-sucedido em termos de correspondência de cor, adaptação marginal e satisfação do paciente.

PALAVRAS-CHAVE

CAD-CAM; Cerâmica; Percepção de cor; Híbrido; Dissilicato de lítio.

INTRODUCTION

Laminate veneers are considered one of the most desirable esthetic restorations owing to their conservatism, superior esthetics, bond strength, durability and high survival rate. It preserves the tooth structure, in which it requires minimal tooth preparation on the labial surface and/or incisal edges, that is kept almost entirely in the enamel. Therefore, laminate veneers offers minimal risk of pulp vitality changes and superior periodontal health status [1]. Additionally, local anesthesia is rarely required, making the dental visit more comfortable for the patient [2].

Lithium disilicate ceramics offer excellent esthetics, biocompatibility, color stability, and translucency, similar to feldspathic ceramics. However, it offers greater fracture resistance and clinical longevity [3].

Different fabrication techniques can be used; either bilayered or monolithic. Bilayered techniques offer enhanced esthetics due to multiple layers and ceramic blends, whereas monolithic approaches provide technical ease and can be efficiently created using CAD/CAM technology. However, monolithic restorations are often considered less esthetic compared to bilayered restorations due to their single-colored body resulting in a less natural appearance [4].

Nowadays, several manufacturers provide polychromatic ceramic blocks that closely resemble the natural dentition in terms of color, translucency, and even fluorescence. This versatility enables more lifelike, natural and aesthetically pleasing results, especially in the esthetic zone, while benefiting from the efficiency and precision of digital manufacturing [5].

VITA ENAMIC multiColor, the most recent hybrid ceramic blocks, introduced by Vita, provide a progressive color transition over six separate layers, from the cervical to the incisal edge to replicate the inherent color progression observed in teeth [6]. Meanwhile, it shows a modulus of elasticity similar to dentin, which allows for more uniform stress distribution under load and increases resistance to crack formation and propagation. This material is indicated for the fabrication of minimally invasive restorations especially laminate veneers, inlays, onlays for molars and premolars, crowns for posterior teeth and implant-supported crowns [7].

Excellent shade match is a challenging procedure and any mismatch could require a restoration remake [8]. Moreover, it serves as an immediate reflection of shade determination and may be evaluated using various visual and instruments methods. One of the most common visual methods is the modified USPHS criteria, which are notably comprehensive [9].

Marginal adaptation is crucial for achieving superior esthetics, periodontal health and durability of veneers. Veneers were also clinically evaluated for marginal adaptation using modified USPHS criteria [10].

Patient satisfaction is vital for evidence-based dentistry and effective communication between dentists and patients [11]. It was measured using VAS [12].

However, data comparing VITA ENAMIC multiColor laminate veneers to the highly esthetic layered lithium disilicate in regards to shade matching, marginal adaptation and patient satisfaction clinically is still lacking. Thus, the aim of this study was to evaluate the shade match, marginal adaptation and patient satisfaction of VITA ENAMIC multiColor anterior laminate veneers and compare it to that of IPS e.max CAD veneers immediately post cementation. The null hypothesis of the study stated that there would be no difference in shade match, marginal adaptation and patient satisfaction between VITA ENAMIC multiColor and IPS e.max CAD anterior laminate veneers.

MATERIAL AND METHODS

Study design

The current study was a randomized clinical trial in which participants were allocated into two groups at random. In the first group (intervention; Group EMC): patients received VITA ENAMIC multiColor laminate veneers. While in the second group (control; EX): patients received IPS e.max CAD laminate veneers.

Sample size

The sample size for this study was determined based on data obtained from a previous study by Mert Yuce et al. [13] and calculated by using CHI-square test, power of 80% and a 5% alpha level of significance. The calculated sample size was 11 patients per group with a total of 22 patients for the full study.

Participant's selection

A total of 22 participants were recruited from the outpatient clinic of the Department of Fixed Prosthodontics of Faculty of Dentistry, Cairo University, Cairo, Egypt.

Eligibility criteria

Inclusion criteria

a. Patients aged 18-55 years who were able to read and sign the informed consent document
b. Patients who were physically and psychologically able to tolerate conventional restorative procedures
c. Absence of active periodontal or pulpal diseases
d. Patients with discoloration such as white spots due to developmental defects as dental fluorosis or acquired discoloration such as discolored incisal edge, tooth fracture that does not involve more than 50% enamel loss, mild tooth malposition, abnormal tooth shapes, peg-shaped lateral incisor tooth

Exclusion criteria

a. Patients with partially erupted teeth
b. Fractured teeth of more than 50% enamel loss
c. Poor oral hygiene
d. Non-vital teeth
e. Generalized wear or TMJ problems or parafunctional habits

RANDOMIZATION, ALLOCATION CONCEALMENT MECHANISM AND IMPLEMENTATION

Patients fulfilling the inclusion criteria were numbered 1 to 22. The participants were randomly assigned into two groups at 1:1 allocation ratio using computerized software [14]. The sequence involved distributing numbers 1 to 22 across a two-column table in a randomized manner.

Each patient within the two groups received an assigned number, which was also inscribed on a large white paper. This paper was meticulously folded eight times before being enclosed within a securely sealed opaque envelope.

An independent researcher opened the envelope in the operating room immediately after secondary impression to determine the veneer material. The envelope was sent to the lab for fabrication of the veneer restoration.

Blinding

The trial participants, outcome assessor and statistician were blinded to the type of the tested materials. However, the operator was not blinded due to the difference in surface treatment protocols for each material prior to cementation (Flowchart 1).

Treatment phases

A total of twenty-two patients who needed laminate veneer for shade modification or fractured incisal edge were selected. Two ceramic materials (IPS e.max CAD and VITA ENAMIC multiColor) were selected for veneer fabrication in this study (Table I). All treatment procedures were performed by the same clinician (N.K.).

Preparatory phase

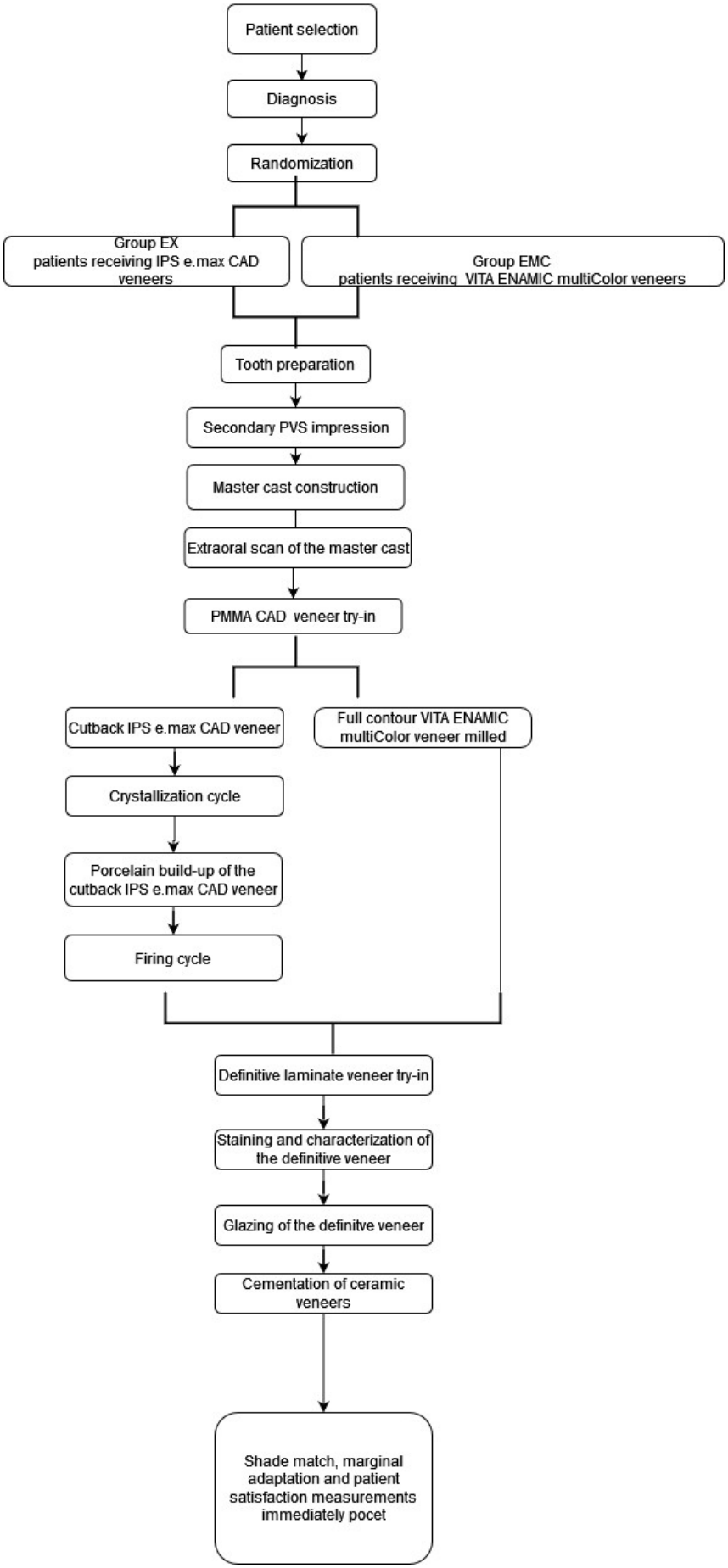
Meticulous scaling and polishing were performed for each patient to remove dental plaque and external stains, that may negatively affect the shade selection. Shade determination of the contralateral tooth was recorded visually using VITA Tooth guide 3D-Master during daylight. (Figures 1 and 2) Study casts were mounted on a semi-adjustable articulator using facebow transfer.

Tooth preparation

Standardized amount of labial reduction of 0.3 mm, 0.5 mm, and 0.7 mm at the cervical,

Table I - The materials investigated in the study

Material name	Description	Manufacturer	Batch number
IPS e.max CAD	Lithium disilicate glass ceramic	Ivoclar Vivadent, Principality of Liechtenstein, Germany	Z01SBP
VITA ENAMIC multiColor	Polymer infiltrated ceramic, dual ceramic polymer network structure	VITA Zahnfabrik H. Rauter GmbH & Co.KG Bad Säckingen, Germany	91810



Flowchart 1 - Schematic diagram of the procedures adopted in the present study.

Figure 1 - Visual shade determination using VITA Tooth guide 3D-Master.

Figure 2 - Assessment of shade match post cementation.

middle, and incisal parts respectively was performed using a three-wheel depth cutter stone and sharp pencil for shading the grooves. A 0.3 mm thick supragingival chamfer finish line was also created. Butt joint incisal preparation of 1 to 1.5 mm depth was standardized using vertical depth grooves created by tapered diamond stone. The amount of tooth prepared was checked using a graduated periodontal probe, guided by an index previously made with addition polyvinyl siloxane rubber base impression material, putty consistency, which was adapted onto the diagnostic wax-up without a tray to record the contours, and then sectioned buccolingually after complete setting to guide the preparation check. Subsequently, stump shade was selected using stump shade guide.

Secondary impression and master cast digital scan

A two-step impression technique using PVS rubber base impression material (Panasil, Kettenbach, USA) was used, and temporary veneer restoration (Structur 2 SC, VOCO, Germany) was constructed directly intra-oral. Secondary impression was poured into dental stone type IV to obtain the master cast, which was then scanned using SWING HD Desktop Scanner (DOF, Korea), an extra-oral scanner featuring 10 μm scanning accuracy, 1.3-megapixel dual cameras for precise scanning, and a high-performance USB 3.0 interface for fast data processing.

Milling of the definitive veneers

CORiTEC 350i PRO, imes-icore, a five-axis wet milling machine was used to mill the definitive veneers, designed using the dental CAD software (ExoCAD galway3.0).

Veneering of IPS e.max veneers

The veneer was airborne-particle abraded with 50-μm glass beads at 10 mm distance with 2 bar air pressure and then the surface was cleaned with a steam jet and subsequently dried. Porcelain buildup of the facial cutback tooth-colored IPS e.max veneer was done using IPS e.max Ceram material.

Definitive veneer evaluation

Each veneer was checked for proper seating and margins were evaluated during the try-in stage. For shade matching, each veneer was compared to the contralateral tooth. During the initial try-in of IPS e.max CAD veneers, two veneers (18%) showed mismatched body shades because the abutment's shade was falling between two shades. Therefore, a slightly lighter shade block was selected, with the intention of adjusting the final color using stains. During the delivery stage, another two veneers (18%) required further shade modification through the application of stains intraorally and were immediately fired [15-17].

For VITA ENAMIC multiColor, during the initial try-in, eleven (100%) veneers matched the body shade due to the polychromatic nature of the material. Nine veneers (81%) exhibited a translucent incisal third, necessitating the application of creamy white stains on the incisal third of the palatal surface to reduce translucency. During the delivery stage, one veneer (9%) required further shade characterization with stains that were light-cured intraorally.

Table II - Results of comparing shade matching scores in the two tested groups (Group EX and Group EMC)

Shade match	Group EX (n = 11)		Group EMC (n = 11)		*p-value	Effect size (OR)
	N	%	n	%		
Alpha	9	81.8	8	72.7	1	1.688
Bravo	2	18.2	3	27.3		

*Significant at p ≤ 0.05. OR: Odds Ratio; %: percentage; SD: standard deviation.

Table III - Results of comparing marginal adaptation scores in the two tested groups (Group EX and Group EMC)

Marginal adaptation	Group EX (n = 11)		Group EMC (n = 11)		*p-value	Effect size (v)
	n	%	N	%		
Alpha	8	72.7	10	90.9	0.586	0.266
Bravo	2	18.2	1	9.1		
Charlie	1	9.1	0	0		

*Significant at p ≤ 0.05.

Table IV - Results of comparing patient satisfaction scores in the two tested groups (Group EX and Group EMC)

Patient satisfaction	Group EX (n = 11)	Group EMC (n = 11)	*p-value	Effect size (d)
Median (Range)	10 (10 – 10)	10 (9 – 10)	0.317	0.154
Mean (SD)	10 (0)	9.91 (0.3)		

*Significant at p ≤ 0.05. ; SD: standard deviation; SD: standard deviation.

Cementation

A heavy rubber dam sheet was used to isolate the anterior teeth, where two universal canine or premolar winged clamps were placed over canine teeth bilaterally and a tissue retractor anterior clamp was placed to isolate the intended tooth. A veneer holding stick was used for easy handling and precise placement of the veneer during cementation. The fitting surfaces of all veneers were treated and silanated according to the manufacturer's instructions and abutment teeth were prepared where total etch protocol was followed using light-cured resin cement (Choice 2 veneer resin cement, translucent shade).

Outcomes measurement

Shade matching

Two experienced observers who were blinded to tested materials, evaluated the restorations for shade matching independently according to the modified USPHS criteria. The restorations were visually inspected immediately post cementation for shade match with the contralateral tooth and grades were recorded (Figure 2).

Marginal adaptation

The two experienced observers also evaluated the restorations for marginal adaptation independently, according to USPHS criteria. The restorations were assessed by direct visual and tactile examination with mouth mirror and explorer of 0.2 mm single-ended working end under magnification of dental loupes immediately post cementation.

Patient satisfaction

A questionnaire was formulated according to the VAS and given to all patients in both groups. VAS scoring was made between 0 to 10 representing a score between full satisfaction and complete dissatisfaction. The patients were left unattended until they completed the questionnaire.

Statistical analysis

For parametric data, Student's t-test was used to compare between the two groups. For non-parametric data, Mann-Whitney U test was used to compare the two groups. The significance level was set at P ≤ 0.05. Statistical analysis was

performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

RESULTS

Regarding shade matching, no statistically significant difference between the two groups (P-value = 1, Effect size = 1.688) was revealed by Fisher's Exact test, where group EX was 1.688 folds prone to have (Alpha) scores than group EMC as shown in Table II.

Regarding the marginal adaptation, no statistically significant difference between the two groups (P-value = 0.586, Effect size = 0.266) was revealed by Fisher's Exact test (Table III).

Regarding patient satisfaction, there was no statistically significant difference between patient satisfaction scores in the two groups (p-value = 0.317, Effect size = 0.154) (Table IV).

DISCUSSION

Porcelain laminate veneers are regarded as one of the most desired restorations owing to their conservatism, superior esthetics, bond strength, durability and high survival rate. Laminate veneers require minimal tooth preparation and are primarily confined to the enamel [1].

IPS e.max ceramic is considered the gold standard for laminate veneers as it offers superior optical characteristics, closely mimicking the natural teeth in terms of translucency, opacity, halo incisal effect and chameleon effect [8]. Additionally, it has superior mechanical properties, bond strength, biocompatibility and processing tolerance for fabricating thin veneer restorations [18]. Meanwhile, milling lithium disilicate glass ceramic blocks in the blue stage enhanced the ease of milling and minimized bur wear [18].

CAD/CAM technology offered highly accurate milled laminate veneer restorations with enhanced precision. Meanwhile, it reduced chair side time, offering a more comfortable experience for the patient [19].

Construction of IPS e.max CAD veneer using cutback technique was used to increase the incisal translucency, add internal characteristics, and create the illusion of depth, thereby enhancing the esthetic [20,21].

VITA ENAMIC multiColor blocks possessed natural chromatic transition integrated in six layers from the cervical to incisal layer. Moreover, the polymer component of VITA ENAMIC multiColor offered resilience, that allowed absorbing chewing forces more effectively and decreased the chance of chipping or fracture [5,6,22-25]. Additionally, hybrid ceramics offered single-visit dentistry since it does not necessitate firing in a ceramic furnace. In addition, VITA ENAMIC multiColor provided adequate bonding with resin cement [22,23].

This study employed a randomized clinical trial since it reduced confounding variables and investigator bias [26]. Randomization guaranteed that the assessments across both groups are equal and the results are not biased by confounding factors [27]. A triple blinded study design minimized potential biases that could affect the interpretation of the results [28].

Sample size calculation prevented wasting research time, resources, and money and ensured that no significant treatment effects were missed due to an inadequate sample size [29].

Shade determination was done to obtain optimum shade match. Visual shade matching was used because it is simple and economical. Vitapan 3D-Master shade guide was used since it has uniform color distribution of shade tabs and uses a clear, logical structure based on value, chroma, and hue [30]. Shade mapping was done to ensure effective communication with the ceramist and thereby excellent shade match and high patient satisfaction [8].

The amount of tooth preparation was standardized in all patients. Thereby, it guaranteed uniform thickness of the veneer restoration, which influences the color outcome [31,32]. Moreover, it reduced dentin exposure which could result in compromised bond strength [23].

External surface characterization and staining was performed to provide seamless blend of the veneer with the patient's natural teeth. Characterization, through the application of extrinsic staining allowed dental professionals to mimic the complex color variations and unique features of natural teeth [33].

Glazing was performed to minimize the adverse effect of roughness on color and increase the strength of the material [34].

The null hypothesis of the study regarding shade match, marginal adaptation and patient satisfaction between VITA ENAMIC multiColor and IPS e.max CAD anterior laminate veneers was accepted.

Regarding the **results of shade match**: the null hypothesis was accepted as the results revealed that there was no statistically significant difference between the two groups, with the alpha score being prevalent in both groups. This might be due to meticulous shade selection using 3D Master tooth shade guide. Also, the appropriate construction technique employing the cutback technique in the fabrication of IPS e.max CAD veneer helped achieve this result, where characterization and staining employed in both groups. Meanwhile, the polychromacity of VITA ENAMIC multiColor block made it feasible to replicate the complex appearance of natural teeth [6].

Although the results showed insignificant difference, **alpha score was higher in IPS e.max CAD group**. This might be attributed to the difference in the nature of the materials used [35]. Additionally, some researchers found that indirect hybrid ceramics have a reduced matching capacity of the neighboring structures compared to IPS e.max [6].

Our findings aligned with those of M ElGendi M, [36] who evaluated the color match of IPS e.max CAD and Lava Ultimate veneer restorations immediately after cementation according to modified USPHS criteria and concluded that all restorations showed Alpha scores.

The results of the present study were in accordance with Fawakhiri et al. [37], who concluded that a good color match (score 1) was detected on the IPS e.max veneers according to Hickel assessment.

Our findings aligned with those of Mosallam et al. [38] who evaluated the color match of lithium disilicate glass ceramic crown restorations immediately after cementation using VITA Easyshade device and concluded that glazed restorations showed statistically significant higher color match compared to polished restorations.

Our findings aligned with those of Attia et al. [39] who evaluated fifty-four vita enamic laminate veneers following traditional and aesthetic pre-evaluative temporary techniques immediately postcementation using modified USPHS criteria. The study concluded that all vita enamic veneers achieved 100% color match (alpha score) at base line results.

The results of the present study were in accordance with Saeed et al. [40] who assessed the color change of twenty-four IPS e.max ceramic laminate veneers using modified USPHS criteria and found that all IPS e.max ceramic laminate veneers exhibited 100% perfect color match (alpha score) immediately post cementation and at follow up periods, irrespective of the preparation design.

However, the results of the present study disagreed with those reported by Lee & Choi [31] who found high color mismatch of HT and LT lithium disilicate laminate veneers when cemented by translucent resin cement. The difference in their results might be attributed to artificial aging and using different evaluation technique that is the spectrophotometer.

Regarding the **results of marginal adaptation:** the null hypothesis was accepted, as the results revealed no statistically significant difference between the two groups, with the alpha score being prevalent in both groups. This might be attributed to the use of CAD/CAM technology, as well as a highly accurate extra-oral scanner, namely DOF SWING HD Desktop Scanner and precise milling with a five-axis milling machine unit [41]. Another factor could be bonding using resin cement that tend to exhibit superior marginal adaptation, specifically in enamel compared to dentin [42]. Additionally, using the butt-joint incisal configuration for tooth preparation facilitated an easy insertion path for the laminate during cementation, while preserving a peripheral enamel layer along all margins [43].

Although the results showed insignificant difference, **alpha score was higher in VITA ENAMIC multiColor group**. This might be attributed to the dual network structure (polymer content) of the VITA ENAMIC multiColor that offers the combination of strength, resilience, and excellent machinability, achieving superior marginal adaptation [7]. Additionally, VITA ENAMIC multiColor blocks do not require additional crystallization firing after milling, which typically involves a 0.2% shrinkage occurring during the densification of lithium disilicate ceramics that can lead to an increased marginal gap [44,45].

Our findings aligned with those of Attia et al. [39] who evaluated vita enamic veneers using modified USPHS criteria immediately postcementation. The study concluded that all vita enamic veneers exhibited 100% alpha score, interpreted as no visible evidence of crevice, catch or penetration of explorer along the margin.

Our findings aligned with those of Osman et al. [43], who evaluated IPS e.max CAD veneers using modified USPHS criteria. The study demonstrated 100% alpha score for marginal adaptation.

Regarding the results of **patient satisfaction:** the null hypothesis was accepted as the results revealed that there was no statistically significant difference between patient satisfaction scores in the two groups, with the alpha score being prevalent in both groups. These results might be attributed to the involvement of patients in shade selection and mock-up modification according to patient aesthetic and functional needs [46]. Furthermore, obtaining patients' consent and verifying the restoration's shape before fabricating the final prosthesis appeared to enhance patient satisfaction [37].

The findings of the current study were consistent with those of Fawakhiri et al. [37] who used Hickel's 2010 criteria to assess IPS e.max veneers for patient satisfaction and came to the conclusion that 98% of participants reported satisfaction with the restorations.

Our findings aligned with those of Attia et al. [39] who evaluated patient satisfaction using modified USPHS criteria and concluded that all participants in the group receiving vita enamic veneers expressed high levels of satisfaction and were assigned an alpha score at the baseline assessment.

The results of the present study were in accordance with Mosallam et al. [38] who evaluated patient satisfaction of glazed lithium disilicate glass ceramic restorations using visual analogue scale and found out that all patients reported complete satisfaction.

However, the results of the present study aligned with those reported by Nejatidanesh et al. [47] who evaluated IPS e.max CAD laminate veneers using visual analogue scale and reported high patient satisfaction, with mean score of 95.5 ± 8.4. This might be attributed to the ability to complete the treatment in a single visit.

The current study showed some limitations including long term follow up.

RECOMMENDATIONS

- It is recommended to conduct further clinical studies to assess the color stability of VITA ENAMIC multiColor veneers against monolithic IPS e.max CAD veneers;
- It is recommended to test the effect of resin cements of different shades on the color match and stability of VITA ENAMIC multiColor veneers versus IPS e.max veneers;
- It is recommended to compare VITA ENAMIC multiColor to other ceramic materials;
- Clinical Implications: It is advisable that clinicians use IPS e.max CAD veneers fabricated using cutback technique to provide restorations with excellent shade match and high patient satisfaction.

CONCLUSIONS

Within the limitations of this clinical study, the following could be concluded: IPS e.max CAD and VITA ENAMIC multiColor veneers provided a successful clinical performance in terms of shade match, marginal adaptation and patient satisfaction.

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Not applicable.

Author's Contributions

NSAAK: Conceptualization, Methodology, Investigation, Writing – Original Draft Preparation, Writing – Review & Editing. HA: Conceptualization, Methodology, Validation, Formal Analysis, Writing – Review & Editing, Supervision. EEY: Methodology, Validation, Formal Analysis, Writing – Review & Editing, Supervision.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Regulatory Statement

This study protocol was reviewed by the Ethics Committee of Scientific Research - Faculty of Dentistry - Cairo University and approved in October 2020 with ID number: 22 10 20. The clinical study was performed in the outpatient clinic of the fixed prosthodontic department clinic at Cairo University. All patients signed an informed consent which was approved by the Ethics committee.

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