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TRANSLUCENCY OF CERAMIC LAMINATE VENEERS FABRICATED WITH DIFFERENT CERAMIC MATERIALS AND TECHNIQUES

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ABSTRACT

Purpose: Comparing the translucency of various recent ceramic laminate veneers, with different fabricating techniques and luted with two types of adhesive systems.

Materials and Methods: Total of 60 discs of 10 mm diameter and 0.7 mm thickness were fabricated, and divided into 4 main groups according to the ceramic materials (Vitablocs Triluxe Forte, VITA Enamic, Ceramill® Zolid and VITA VM®9) 15 specimens for each, that divided into 3 subgroups, with 5 specimens (control and two cement systems groups). All specimens were suspected to Translucency measuring procedures, using a spectrophotometer, to calculate its Translucency Parameter, and Contrast Ratio values before and after adding the cement systems.

Result: F-test ANOVA revealed a significant difference in Translucency Parameter (TP) mean value when comparing the four materials in this study. The TP means were arranged in a descending way and showed that; Triluxe (No Adhesive) came in the 1st rank, and recorded the highest TP (3.5225±0.02217), followed by (RelyX Veneer) and the lower mean recorded by (RelyX Ultimate) for the same material where TP (3.44±0.01414). However Ceramill®Zolid (No Adhesive) recorded the 10th rank TP (2.84±0.0001), then (RelyX Veneer) followed by (RelyX Ultimate) came in the last rank as the least TP (2.78±0.00816).

Conclusion: It was noticed that, within each ceramic material, the no adhesive application, showed the highest TP, then with RelyX Ultimate adhesive showed the least TP. The first rank of TP appeared in Trilux material.

KEY WORDS: Translucency, Ceramic Laminate veneer,

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INTRODUCTION

The patient's request for treating unaesthetic anterior teeth is relentlessly developing. In like manner, a few treatment alternatives have been proposed to reestablish the aesthetic appearance of the dentition. For a long time, the most unsurprising and durable aesthetic adjustment of anterior teeth has been accomplished by the preparation of full crown. However, this approach without any doubts is most invasive with generous expulsion of a lot of sound tooth substance and conceivable antagonistic impacts on nearby pulp and periodontal tissues. The great advance in bonding ability to both enamel and dentin made with the presentation of multi-step total-etch adhesive procedures, alongside with the improvement of superior and universal small-particle hybrid resin composites has prompted more conservative therapeutic adhesive procedures to restore unaesthetic teeth.[1]

In the dental field, a veneer is a coating layer which overlays a surface of a tooth, for enhancing the appearance and shape of the tooth or saving the tooth's surface from harm. A full veneer crown can be defined as "a restoration that coats all the aspects of the tooth's crown (mesial, distal, facial, lingual and occlusal).

Veneers are an outstanding method for the dental practitioner. A dental specialist may utilize one veneer to reestablish a solitary tooth that may have been cracked or stained, or multiple teeth to make a "Hollywood" kind of makeover. Numerous individuals have teeth with interdental spaces that may not be effectively obliterated by orthodontics. A few people have worn away the edges of their teeth bringing about a forever an aging appearance, while others may have malpositioned tooth/teeth that seem warped. Multiple veneers can close these spaces, increase the length of the teeth that have been shortened by wear, fill the dark triangles between teeth caused by gingival recession, give a uniform shading, shape, and symmetry, and make the teeth seem straight. Dental practitioners additionally prefer thin porcelain veneers to protect worn teeth from further damage. It is likewise recommended for yellow teeth that can't be bleached effectively. Thin veneers are a very successful choice for geriatric patients with worn teeth. Much of the time, minimal or no tooth reduction is required for porcelain veneers [2,3]

The field of dentistry is always keeping an eye on advances in restorative materials that are expected to be maximally aesthetic, strong, and minimally-invasive.

Vitablocs® Triluxe Forte, is a fine-structure feldspar ceramic, with natural translucency which gives top esthetics. It's indicated for crowns, inlays, onlays, and veneers. it does not need crystallization firing, and it can be flexibly customized using enamel porcelains and stains.

Vita Enamic®, is the world's first dental hybrid-ceramic with a dual network structure, which combines the positive characteristics of composite and ceramic. The dominant ceramic network in this dental material is strengthened by a polymer network, whereby both networks penetrate fully.[4] It ® is indicated in the fabrication of crowns, inlays, onlays, veneers and implants. It is advantageous over other all-ceramic systems by its enormous loading capacity due to absorption of the masticatory forces, high VITA VM®9, is a highly aesthetic, fine-structure feldspar ceramic which is mainly composed of pure-grade potash and albite feldspar materials that offer brilliant shade effects as well as optimum physical properties, such as extreme flexural strength values. It has a homogenous, compact surface, so it can support outstanding grinding and polishing, particularly in situ. This results in smooth and densely compact surfaces. [4]

Zirconia showed up as a promising material and a brilliant decision in aesthetic dentistry, yet its bonding to tooth surface was noticed to be lower than expected. In the present time, Bonding of zirconia depends on the presence of a surface adhesive primer, which permits its bonding to the tooth surface.[5]

Ceramill®Zolid is a high translucency monolithic zirconia, for full anatomic units with flexural strength up to 1500 MPa. The translucency, which is produced by sintering at 1450 degrees Celsius, is very close to that of the natural teeth. It can fulfill increased patient demands for a greater depth effect of the restoration. The material stability of Ceramill®Zolid makes it suitable for non-veneered, fully anatomical restorations, which are functionally fabricated from one piece in combination with Ceramill® CAD/CAM system (Ceramill®Motion 2).[6]

Munsell Color System

Munsell color system is the oldest color order system and has been used in dentistry to define colors in terms of value, hue and chroma. In the visual perception system, the value represents the color lightness or darkness, running from 0 (black) to 10 (white). Munsell chroma represents the intensity of a particular hue; it is an open-ended scale ranging from 0 (achromatic colors) to maximum depending on the hues. Finally, Munsell hue is related to the similarity of the sample to the perceived colors (red, orange, green, blue) or to the proportions of two perceived colors.[7]

The hue of an object can be red, green, yellow, and so on, and is determined by the wavelength of the reflected and/or transmitted light observed. The place of that wavelength in the visible range of the spectrum determines the hue of the color. The shorter the wavelength, the closer the hue will be to the violet portion of the spectrum; the longer the wavelength, the closer it will be to the red portion. In the Munsell color system, hues are divided into 10 gradations: yellow, yellow-red, red, red-purple, purple, purple-blue, blue, blue-green, green, and green-yellow.Yellow and yellow-red is a most range between natural teeth fall into. [7]

Chroma is defined as the intensity of a hue. The terms saturation and chroma are used interchangeably in the dental literature; both mean the strength of a given hue or the concentration of pigment.

Value is defined as the relative lightness or darkness of a color or the brightness of an object. The brightness of any object is a direct consequence of the amount of light energy the object reflects or transmits.[7]

CIE Color System

Another commonly used color specification system was developed by the Commission Internationale de l'Eclairage (CIE, International Commission on Illumination). This system reveal the reflectance data in the visible region of the spectrum, and, by tristimulus colorimetry, the conversion of these data to a set of numerical coordinates, which define the color of the object measured.[7]

In the CIE system, the color sample's spectral distribution curve and the spectral power distribution of the selected illuminant are combined to obtain three stimulus values X, Y, and Z. these values can be transformed to L*, a* and b* values which represent a uniform color space. L* is a measure of lightness similar to Value in the Munsell system. The a* and b* values represent positions on red/green and yellow/blue axis respectively.[7]

Transparency, Translucency and Opacity

Translucency is one of the optic properties of dental materials. The light can pass through the material and don't scattered. Translucency is a superset of transparency. It allows light to pass through, but with scattering because the light photons scatter at either of the two interfaces where there is a change in the index of refraction, or internally. The opacity is opposite property of translucency.[8]

When a material, encounters by light, it can interact with it in different ways. These interactions depend on the light wavelength and the material nature . Photons interact with an object by reflection, absorption and transmission. There are materials, such as plate glass and clean water, transmit much of light that falls on them and reflect little of it; such materials are called transparent. Many liquids and aqueous solutions are highly transparent. The molecular structure of most liquids and clearance of structural defects (voids, cracks, etc.) are mostly responsible for excellent optical transmission.[8]

The opaque materials that donot transmit light are called. Many such substances have a chemical composition which includes absorption centers. The absorption of many substances of white light frequencies are selective .

The translucency of the enamel and dentin is wavelength-dependent; the higher the wavelength, the higher the translucency value. Material thickness is another factor that affects the translucency

Tooth and porcelain surface gloss also interferes with the correct identification color due to specular reflection. There are two forms of transmittance (specular and diffuse) and each one depends upon the method of measurement. In the diffuse transmittance, the measurement includes all the light passing through the material plus all the light scattered in a forward direction. For the specular transmittance, the measurement excludes the proportion of scattered light that does not reach the detector.[8]

Variables Affecting Translucency

Various factors related to the material itself, the specimen, or the measurement procedure can affect the translucency: specimen thickness, amount of crystals within the porcelain matrix, surface texture, material's batch, degree of porosity, and illuminant·

The greater the material thickness, the lower its translucency is the amount of light that is absorbed, reflected and transmitted will depend on the number of crystals within the matrix, their chemical nature and the size of particles compared to the incidents light's wavelength

Surface texture is another variable shown to influence the translucency of porcelain. Surface gloss would interfere with the correct identification of tooth and porcelain color due to specular reflection.A very smooth surface would cause the reflectance of the light at the same angle as incidence, resulting in specular reflection.[7]

Modern dental porcelains display varying degrees of translucency. They are manufactured by the addition of opaque materials to the matrix, and their refractive indices differ from those of feldspathic glass. Their volumetric content and, more recently, their size, can be balanced to simulate the different natural tooth structures quite successfully.[9]

Optical Behavior of Current Ceramic Systems

In the last 15 years, there have been amazing developments in the field of new aesthetic ceramic materials for dental prostheses. At the same time, various new techniques have been developed to accompany these new materials. However, the precise imitation of the beauty and characteristics of natural teeth remains a particularly complex and difficult procedure, both in the clinic and laboratory.[9]

The shade and color of the tooth is influenced by several factors, such as the spectral energy distribution of the light source, the sensitivity of the observer's eye, and the tooth spectral characteristics with respect to light absorption, reflection and transmission. it is clear that the fabrication of an ideal, natural-looking restoration require not only the matching of the color components of hue, value, and chroma but also the blending of the specific characteristics of the adjacent teeth.

The same deep translucency found in a natural tooth has to be provided to the restorations by controlling the light absorption, reflection, and transmission in the ceramic material. At the same time, the optical phenomena of opalescence and fluorescence that characterize natural tooth structure under certain lighting conditions must also be present in ceramic restorations

The overall optical behavior of a permanently cemented all-ceramic restoration is dependent on three factors; the underlying tooth structure, the luting agent, and the structure of the ceramic material.[27]

Underlying Tooth Structure

Because of the increased light transmission of all-ceramic restorations, there is an influence from the underlying tooth structure, whether normal, discolored or treated with a post-and-core or a build-up. The recent technologies of ceramic, zirconium and fiber-reinforced posts offer new possibilities and new restorative solutions to that aspect.[27]

Luting Agent

As early as 1933, Clark addressed the importance of the color of the luting medium in all-ceramic restorations. The extent to which the color of the luting agent could influence the overall result was estimated to be 10% to 15% by Touati et alin 1993. A 1996 study by Paul et al, questioned these results and concluded that the influence of the luting agent is less than 5%. Therefore, varying changes in hue with light-transmitting composite luting agents are particularly impossible. For this reason, the authors recommended the use of one rather translucent luting agent for all-ceramic restorations instead of working with multiple color variations

In this research, a spectrophotometric analysis will be done for all the specimens of the different materials used, with and without two different adhesive systems, to identify the effect of adhesives on the transmittance and absorption ratios of each material.

MATERIALS AND METHODS

Total of 60 discs of 10 mm diameter and 0.7 mm thickness were fabricated, and divided into 4 main groups according to the ceramic types that studied in this research. Each group contain 15 specimens was divided into 3 subgroups, with 5 specimens for each (control and two cement systems groups).

All specimens were suspected to Translucency measuring procedures, using a spectrophotometer, to calculate its Translucency Parameter, and Contrast Ratio values before and after adding the cement systems which used in the present study.

Fabrication of VITA VM®9 Specimens

An acrylic mold was digitally designed and fabricated with a thickness of 0.7 mm and 10mm diameter by Laser technology used for building VITA VM®9 layering ceramic specimens.

The mold consists of three main parts; mold frame, two halves of specimen space, were fixed with its frame to give support to VITA VM®9 material during molding.

Vita Porcelain Powder of shade A1 was mixed with modeling liquid and applied to the specimen space in the acrylic mold to take the disc form (10 mm in diameter and 0.7 mm in thickness) supported on an porcelain pillow for firing .

The mold (frame and two halves) were removed and discs on the furnace tray put into a firing process with an increasing firing temperature up to 900°C with final long term cooling temperature down to 650°C. Firing process took about 20 minute to finish.

The fired disc was adjusted for the diameter and thickness. VITA Akzent® Plus glazing liquid, (Vita Zhanfabrik, Germany), was applied to all specimens by a small brush and set ready to be fired.

Fabrication of CAD/CAM Specimens:

Ceramill Mind software, (Amann Girrbach, Germany & Austria), was used to digitally design the specimens of Vitablocs® Triluxe Forte, VITA Enamic®, and Ceramill®Zolid with a diameter of 10 mm and a thickness of 0.7 mm.

Blocks of Vitablocs® Triluxe Forte, VITA Enamic®, and Blanks of Ceramill®Zolid were fabricated by Ceramill Motion 2 milling machine,

Fabrication of Ceramill® Zolid specimens

Zirconia discs were milled according to the pre-designed measurements by Ceramill software. Ceramill®Motion 2 Roto®standard tools were inserted into the tool holder and the blank was inserted into the its holder. Milling spindle milled zirconia specimens, using dry milling mode, which is optimal for zirconia.

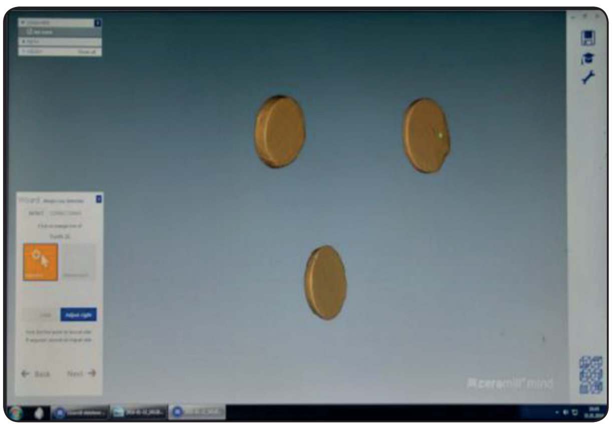

Fig. (2) Ceramill Mind software during designing the specimens.

After milling, the specimens were immersed in Ceramill®Liquid shade A1 bottle for about 2 minutes, taken out and left to dry.

The specimens were sintered with increasing temperature up to 1450 – 1500°C for about 10 – 12 hours.

Fabrication of Vitablocs® Triluxe Forte and VITA Enamic® specimens:

Vitablocs® Triluxe Forte and VITA Enamic® blocks of shade A1 were selected, and fixed to the block holder slot (one block per time).

The specimens were milled according to the pre-designed dimensions, using wet milling mode.

Vitablocs® Triluxe Forte and VITA Enamic® blocks do not require thermal refinement processes, such as staining, glazing or crystallization firing (sintering).

Spectrophotometer:

Translucency Parameter (TP) of all specimens was measured by spectrophotometer, Varian Cry 5000 UV-VIS, (Agilent Technologies, USA), before and after addition of the adhesive cements layers, to detect the effect of the different cements on TP.

Spectrophotometric tests were achieved in the National Institute of Standards (NIS, Giza).

Translucency Parameter (TP) values were calculated according to the following equation:

$$\Delta E = [(L^*b - L^*w)^2 + (a^*b - a^*w)^2 + (b^*b - b^*w)^2]^{1/2}$$

letters (b) and (w) refer to color coordinates over the black and white backgrounds respectively

RESULTS

TP values of all specimens, before and after adding the adhesive cement layers, were listed in the following table I:

TABLE (I) Mean ± SD of the TP of groups and subgroups

subgp Gp	NO Adhesive	RelyX Veneer	RelyX Ultimate	F	P
Triluxe	3.5225± 0.02217	3.4700± 0.02449	3.4400± 0.01414	16.200	0.01*
VM9	3.1825± 0.01258	3.1350± 0.02380	3.1175± 0.02872	8.758	0.02*
Enamic	2.9125± 0.00500	2.8625± 0.00500	2.8400± 0.01155	90.136	0.001*
Zolid	2.8375± 0.00500	2.8000± 0.01414	2.7800± 0.00816	35.057	0.001

F-test ANOVA revealed a significant difference in Translucency Parameter (TP) mean value when comparing the four materials in this study. The TP means were arranged in a descending way and showed that; Triluxe subgroup (No Adhesive) came in the 1st rank, and recorded the highest TP (3.5225±0.02217), followed by subgroup (RelyX Veneer) and the lower mean recorded by subgroup (RelyX Ultimate) where TP =3.44±0.01414).

As regard VITA VM®9, subgroup (No Adhesive) recorded the 4th rank (TP = 3.1825±0.01258), followed by subgroup (RelyX Veneer) Then subgroup (RelyX Ultimate)

Also VITA Enamic ,subgroup (No Adhesive) recorded the 7th rank (TP= 2.9125±0.005), followed by subgroup (RelyX Veneer,) then subgroup (RelyX Ultimate)

However Ceramill®Zolid subgroup (No Adhesive) recorded the 10th rank (TP = 2.84±0.0001), then subgroup (RelyX Veneer) followed by subgroup (RelyX Ultimate) came in the last rank as the least TP (2.78±0.00816).

	Triluxe	VM9	Enamic	Zolid	F	P
NO Adhesive	3.5225± 0.02217	3.1825± 0.01258	2.9125± 0.00500	2.8400± 0.0001	193.5	0.001
RelyX Veneer	3.4700± 0.02449	3.1350± 0.02380	2.8625± 0.00500	2.8000± 0.01414	107.4	0.001
RelyX Ultimate	3.4400± 0.01414	3.1175± 0.02872	2.8400± 0.01155	2.7800± 0.00816	119.1	0.001

It was noticed that, within each material group, the subgroups with no adhesive application, showed the highest TP mean, then the subgroups with RelyX Ultimate adhesive, which showed the least TP mean

Translucency Parameter (TP) comparison (Mean ± SD) between the different groups (according to the variant of material), was done by using ANOVA test, and data was recorded

The TP mean value of specimens of all groups with no cement layer were compared separately to the specimens with a cement layer of RelyX Veneer, and the specimens with a cement layer of RelyX Ultimate. The results were recorded in the following table:

Groups			Mean Difference	Significance
VITA VM 9	No Adhesive	RelyX Veneer	0.05250	0.006
		RelyX Ultimate	0.08250	0.000
Vitablocs Triluxe Forte	No Adhesive	RelyX Veneer	0.04750	0.016
		Ultimate	0.06500	0.003
VITA Enamic	No Adhesive	RelyX Veneer	0.05000	0.001
		Ultimate	0.07250	0.001
Ceramill Zolid	No Adhesive	RelyX Veneer	0.03750	0.001
		Ultimate	0.05750	0.001

DISCUSSION

Laminate veneers are a fantastic conservative treatment of unaesthetic anterior teeth. The continued development of dental ceramics offered clinicians many options for creating highly aesthetic and functional porcelain veneers. This evolution of materials ceramics and adhesive systems permitted improvement of the aesthetic of the smile and the self-esteem of the patient.

Clinicians should understand the latest ceramic materials in order to be able to recommend them and their applications and techniques and to ensure the success of the clinical case.

The present study aimed to put different dental materials into comparison to define the most proper material with the best esthetics and translucency.

Four sorts of dental materials were used to fabricate the specimens in this study. These materials were, Vitablocs Triluxe Forte porcelain (Vitazhanfabrik, Germany), VITA VM®9 Porcelain (Vitazhanfabrik, Germany), Vita Enamic (a hybrid ceramic introduced by Vitazhanfabrik, Germany), and Ceramill®Zolid zirconia (Amann-Girrbach, Germany & Austria). The specimens were planned to be designed in the form of discs with a 10mm diameter, and a 0.7mm thickness.

Out of concern for clinical relevance, the specimens were fabricated at 0.7mm thickness since it is the minimal thickness recommended by manufacturers in the middle third of a tooth receiving a porcelain veneer.

The materials that evaluated in this study are basically formed by a glass matrix as Vitablocs® Triluxe Forte, is a fine-structure feldspar ceramic, with natural translucency which gives top esthetics as it does not need crystallization firing, and it can be flexibly customized using enamel porcelains and stains .

Also VITA VM®9, is a highly aesthetic, followed the Triluxe group in the TP as it is a fine-structure feldspar ceramic which is mainly composed of pure-grade potash and albite feldspar materials that offer brilliant shade effects .

According to Heffernan (2002), the amount of light that is absorbed, reflected and transmitted will depend on the amount of crystals within the matrix, their chemical nature and the size of particles compared to the incident light's wavelength. The results of this study are in accordance with Heffernan's statement, since,

Ceramill®Zolid (Zirconia) which is a polycrystalline ceramic with no glass content was considered to be the least translucent.

The results also showed that different porcelains present different translucencies, which is in agreement with previous studies that compared various all ceramic systems (Heffernan et al., 2002 Part II; Yu et al., 2009; Li et al., 2009)

Since there are several variables, that can affect the translucency of the ceramic systems, it is difficult to compare translucency in terms of absolute values. Therefore, the relative translucency was used, and comparisons among different studies were made considering translucency ranks. The results of the present study showed that each specimen group showed different translucencies.

The present study also showed how a specimen translucency was affected after the application of the two adhesive cement systems (separately) to the specimens, then Translucency Parameter (TP) values were recorded to detect TP changes. The first adhesive system was RelyX Veneer (3M ESPE, USA), and the second system was RelyX Ultimate (3M ESPE, USA).

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