TO COMPARE THE TRANSLUCENCY OF ZIRCONIA BASED CERAMICS WITH DIFFERENT CORE AND VENEER THICKNESS COMBINATION – AN *IN VITRO* STUDY

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In partial fulfilment for the degree of

MASTER OF DENTAL SURGERY

BRANCH – I

DEPARTMENT OF PROSTHODONTICS

& CROWN AND BRIDGE

2016 – 2019

CERTIFICATE

This is to certify that the Dissertation entitled "**TO COMPARE THE TRANSLUCENCY OF ZIRCONIA BASED CERAMICS WITH DIFFERENT CORE AND VENEER THICKNESS COMBINATION– AN *IN VITRO* STUDY"** by **Dr.KARTHICK P.A** Post Graduate student MDS Prosthodontics & Crown And Bridge, Madha Dental College & Hospital-Chennai – 69 Submitted to The Tamilnadu Dr. M.G.R. Medical University the MDS Degree Examination April 2019 is bonafide research work carried out by him under my supervision and guidance

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This is to certify that this dissertation work titled **"TO COMPARE THE TRANSLUCENCY OF ZIRCONIA BASED CERAMICS WITH DIFFERENT CORE AND VENEER THICKNESS COMBINATION - AN *IN VITRO* STUDY**" of the candidate **Dr.KARTHICK P.A** with Registration Number **241611502** for the award of ………………………… in the branch of Prosthodontics & Crown and Bridge. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **2%** percentage of plagiarism in the dissertation.

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DECLARATION OF THE CANDIDATE

I, **Dr. KARTHICK P A** hereby declare that this dissertation titled "**TO COMPARE THE TRANSLUCENCY OF ZIRCONIA BASED CERAMICS WITH DIFFERENT CORE AND VENEER THICKNESS COMBINATION– AN *IN VITRO* STUDY**" is a bonafide and genuine research work carried out by me under the guidance of **Dr.SHARMILA HUSSAIN, MDS, PhD**. Professor & Head, Department of Prosthodontics & Crown and Bridge, Madha Dental College and Hospital, Chennai -600069.

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Principal Investigator: Dr. KARTHICK.P.A 2016

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The request for an approval from the Institutional Ethical Committee (IEC) considered on the IEC meeting held on at the Principal's Chamber Madha Dental College and Hospital, Kundrathur, Chennai- 69 is granted subsequent to her modification letter dated and you are

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ABSTRACT

TOPIC OF THE STUDY: TO COMPARE THE TRANSLUCENCY OF ZIRCONIA BASED CERAMICS WITH DIFFERENT CORE AND VENEER THICKNESS COMBINATION – AN *IN VITRO* STUDY

Objectives

* To study the influence of core & veneer thickness on the translucency of zirconia based ceramics.
* To study the effect of core & veneer thickness on color matching of zirconia based ceramics.

Materials and Methods:

In this study a total of 45 zirconia disc specimen (n=15) were fabricated with different core and veneer thickness and evaluated the translucency of zirconia disc, with vita easy shade spectrophotometer. To study the translucency of these zirconia disc on stained teeth with different test solution, six groups of test solution was used. The need for greater translucency or masking ability was identified according to the thickness of the core foundation material.

Results: The translucency of the restoration is best when there is a minimum thickness of (0.5mm+1.00mm) core and veneer is used. The color masking ability of the zirconia disc is superior for Orange II test solution followed by Alizarin red test solution and Tea test solution.

Conclusion: The translucency of zirconia ceramics is determined by the specific microstructure of the material. For an overall restoration thickness of 1.5mm, the change in the thickness of zirconia based ceramic veneer is a major factor in determining the translucency of the restoration.

The optical property of zirconia restorations helps clinicians to achieve better esthetic than with metal-ceramic restorations. This optical property of the restoration material is compromised when used for metal post and core, a discolored substrate, or a titanium implant abutment, to avoid this compromised esthetic situation the zirconia coping or a sufficient veneered porcelain can be used.

Keyword: Zirconia ceramics, Translucency, Thickness.

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LIST OF ABBREVATION

CIE	-	International Commission on Illumination
Co Cr	-	Cobalt chromium
LV	-	Layered Veneering
DV	-	Digital Veneering
OV	-	Overpressed Veneering
+ve	-	Positive
-ve	-	Negative
%	-	Percentage
>	-	Greater than
<	-	less than
CAD/CAM	-	Computer-aided design & Computer-aided manufacturing
CR	-	Contrast ratio
MPa	-	Mega pascals
TP	-	Translucency Parameter
SR	-	Spectroradiometric
Y_2O_3	-	Yttrium hydroxide
Mg-PSZ	-	Zirconia magnesia
TZP	-	Titanium stabilized Zirconia Porcelain
g	-	Gram
mg	-	Milligram
ml	-	Milliliter
mm	-	Millimeter
p-value	-	Probability value
sig	-	Significant
NS	-	Non Significant
µm	-	Micro meter

INTRODUCTION

The face and the teeth are the most important individual characteristic of a man, and the teeth along with its hard and soft tissue components contributes to two thirds of facial structure. The dentist should create, preserve and enhance the smile of the patient without impairing its function. There are several factors which determine the dental esthetics, among which the primary factors are the translucency of the core and the selection of materials.

The first priority for patients seeking prosthodontic treatment is the esthetics. The appearance of the maxillary anterior teeth is more important for facial and dental esthetics, the dental esthetics in turn depends on the translucency of the teeth, natural color of the teeth and optimal hard and soft tissue relationship which should be in harmony with the facial appearance(1)

Shade selection is one of the most important criteria for a restoration especially in restoring a anterior teeth. All ceramic crowns offer the best possible option when compared to other material for a discolored tooth to maintain its esthetic, function, durability and longevity of the restoration· (2) Final shade of an esthetic restoration depends on several factors such as translucency, opacity, shade of the porcelain, the combination of ceramic layers, porcelain brand, the number of porcelain firings, and condensation technique.

The restoration of anterior and posterior teeth are better altered with zirconia-based restorations, due to their superior mechanical properties and excellent esthetics. [3]

A zirconia coping provides high strength, while a veneering porcelain creates a natural appearance for these restorations. [4] Additionally, a zirconia coping manifests a nonmetallic margin because of the natural white color of zirconia based ceramic. [5, 6]

A 1-mm-thick zirconia ceramic as a coping material demonstrates an approximately. 37% visible light transmittance, and therefore zirconia ceramic is called a semi translucent material.[7] This optical property of zirconia restorations helps clinicians to achieve better esthetic results than with metal-ceramic restorations.[8] In patients with high esthetic demands, the ceramic with good physical and optical properties is the material of choice which matches the natural dentition. The typical thickness of no preparation veneers is stated to be 0.3mm, a minimally invasive solution for certain esthetic situations. The manufacturer have introduced the new ceramic systems in dentistry, which has improved mechanical and translucent property compared with the conventional feldspathic porcelains. [9]

Compared to other materials, all ceramic veneers have better esthetics. Studies have shown that the opacity of core specimens enhances the esthetics of the restoration. Therefore, the opacity can be increased by increasing the specimen thickness, increasing the structure of the veneering porcelain, reflectance at the interface between the core and the veneering porcelain, the presence of porosities between the layers and any changes in the constituents of the core material with additional firing cycles.

To achieve the optimal esthetics, the translucency of the core and veneer system plays the major role. The ceramic translucency can be affected by thickness of the core, core crystalline structure and the number of firings. The presence of reduced crystalline structure and the refractive index of the crystals which is close to that of the matrix will cause less scattering of the light. Leucite and lithium disilicate have refractive indices close to that of the porcelain matrix. The color replication process of dental porcelain consists of two phases namely shade selection phase and shade duplication phase.

The thickness of the Core required for the lithium disilicate restoration reinforced with ceramic should be 0.8 mm and the veneering material should be as thin as 0.7 mm. The IPS e max ceramic veneering material consists of micro fluorapatite and nano fluorapatite crystals.

It is highly translucent due to its optical compatibility present between the glassy matrix and the crystalline phase. This minimizes the internal scattering of the light as it passes through it. The oxides of Zirconium are usually added as the opacifiers. The varying color differences between the groups and the varying shade reproduction among them are resulted from the addition of these opacifiers in different percentages.

The translucency, color, outline form and the surface are the important factors which have to be considered while dealing with the patient satisfaction for an esthetic restoration. There are some disadvantages with porcelain fused to metal restorations such as the chipping of veneering ceramic, exposure of the metal, and the lack of translucency, some metals that are used for the restorations have the ability to promote carcinogenic activity. [10] These metals are known to cause “graying” in the gingival margin that reduces their usage. [11] Evolution of all ceramic material is a boon to the field of cosmetic dentistry. [12]

Heat pressed ceramic restorations are used for the fabrication of frameworks on vital as well as for the discolored tooth or even as a titanium abutment to have better esthetic results. The good esthetic result of heat pressed ceramic restoration is due to its color rendering and optical properties which could simulate the natural teeth appropriately. Apart from esthetics they have excellent biocompatibility, strength, and surface texture. The heat pressed ceramic restoration yields an appearance of a vital tooth by providing the restoration which could permit the light transmission to the underlying tooth structure, by minimizing gingival shadow.[13]

However, predominantly the core material contributes for the color of an all ceramic restoration. Lifelike restorations are fabricated by masking the substructure by using opaque cores.[14] Hence, it could be presumed that the shade of the stained tooth is masked by different opacities of the core of all ceramic system. In this study the thickness of the veneer and core and its influence on the translucency of zirconia based ceramics was investigated. Further the effect of core thickness on the color masking ability of zirconia based ceramics were also investigated.

AIM AND OBJECTIVES

Aim:

To study the effect of veneer thickness of zirconia based ceramics on translucency.

Objectives:

- To study the influence of core & veneer thickness on the translucency of zirconia based ceramics.
- To study the effect of core & veneer thickness on color masking ability of zirconia based ceramics.

Scope of study:

The need for greater translucency or masking ability should be identified according to the shade of the remaining tooth structure or the core foundation material. With the introduction of new ceramic systems, clinicians must become familiar with the translucency of different porcelain systems to ensure the choice of an appropriate restoration material.

Null Hypothesis: The thickness and the translucency of zirconia based ceramics is not affected by core or veneer thickness.

Alternative Hypothesis: The translucency of zirconia based ceramics is affected by core and veneer thickness.

REVIEW OF LITERATURE

Zircon has been known as a gem since ancient times. The name zirconium comes from the Arabic “Zargun” (golden in color) which in turn comes from the two Persian words “Zar” (Gold) and “Gun” (Color). Zirconia is a crystalline dioxide of zirconium. In 1776, porcelain making was the topic of a review paper given at the Academy of Sciences in Paris. In 1770 another apothecary, working with porcelain formulations and then high technology kilns of the Guehard Porcelain Factory, they succeeded by 1774 in fabricating a complete denture for Duchateau. In 1808 another Parisian dentist, Giuseppangelo Fonzi, significantly improved the versatility of ceramics by firing individual denture teeth, each containing a platinum pin. This invention allowed teeth to be fixed to metal frameworks enabling: (1) partial denture fabrication (2) reparability and (3) increased aesthetics. Platinum had only been known to Europeans since around 1741 and given its extremely high melting point (1769 ̊C) was generally only worked into small wires and crucibles by hammering individual red-hot nuggets. One major advance in porcelain itself came in 1962 with the development of a formulation that could be fired on common dental casting alloys. This invention built on a paper published in the Journal of the American Ceramics Society (JACS) demonstrating an oddity in the thermal expansion of a certain feldspar rock with a potassium content over 11% when melted and cooled quickly, forming a glass. When reheated, this glass had an extremely high thermal expansion due to the formation of a new crystalline component not in the original rock, called leucite Due to an increasing interest in esthetics and concerns about toxic and allergic reactions to certain alloys, patients and dentists have been looking for metal-free tooth-colored restorations.

Therefore, the development of new high strength dental ceramics, which appear to be less brittle, less limited in their tensile strength, and less subject to time dependent stress failure, has dominated in the later part of 20th century. These capabilities are highly attractive in prosthetic dentistry, where strength and esthetics are of paramount importance.

Quantifying the color of teeth is highly difficult according to the aesthetic aspects. Color perception varies from person to person and is highly subjective and it depends on individual variation. Modern ceramic systems rely on relatively opaque core materials to provide strength. Many systems have overlying veneer porcelains for esthetics, but the core material contributes to the overall color of the restoration, as well as its translucency.

To utilize the favorable qualities of ceramic material, a new technique was developed, the “porcelain press technique.” Using this simplified supplementary technique in which alumina-strengthened ceramic material is first vacuum fired and then compressed in the furnace, any type of inlay, crown or bridge (fixed partial denture), can be reproduced enhancing the qualities, dense, strength and accuracy. Several researchers developed different techniques to achieve the maximum esthetics by producing difference in translucency of core and veneer. There are limited data available on the translucency of the shaded zirconia cores.

The esthetic outcome of all ceramic restorations can be affected by the clinical situation and Laboratory factors. The clinical situation such as color scale, source of light during the time of color evaluation, characteristic of the core material, color of the adjacent teeth, type of luting cement used and presence of the root post are some of the clinical situations that could affect the esthetic outcome of the all ceramic restorations.

The laboratory factors such as temperature during the fabrication, thickness of the disc, ceramic condensation, and the number of firing cycles also determine color of all ceramic restoration. The opaque core will sufficiently mask the substructure and enable the fabrication of lifelike restorations. Therefore, it could be hypothesized that different opacities of the core of all ceramic system mask the color of stained tooth.

The typical thickness of no preparation veneers is stated to be 0.3mm, a minimally invasive solution for certain esthetic situations. New ceramic systems, for which the manufacturers claim translucent properties comparable with feldspathic porcelains along with improved mechanical resistance have been introduced in dentistry.

The tooth specimen was divided into three areas: enamel, outer dentin (just inside the dentinoenamel junction), and inner dentin (just lateral to the pulp chamber). Three points without light reflection were chosen in each area for color evaluation. Subsequently, the image of the tooth specimen was transformed to derive a set of numerical values in terms of the International Commission on Illumination (CIE) Lab system with image processing software

Micheal *et al* (2002) [15] evaluated the contrast ratio from luminous reflectance by placing the specimen on a black and white background and obtained Yb/Yw value under CIE illuminant D_{65} on 2-degree observer function. In this study they fabricated Core specimens of Empress dentin, Empress 2 dentin, In ceram alumina, Inceram spinell, In Ceram Zirconia and Procera All ceram compared with veneered vitadur Alpha opaque dentin, a clear glass disc and a high noble metal ceramic alloy veneered with vitadur omega dentin. Result obtained in this study shown decrease opacity of all materials other than in zirconia and metal ceramic specimens.

Yunlong Zhang *et al* (2004) [16] This study was to access the influence of powder/liquid mixing ratio on porosity and translucency of dental porcelains. Duceram LFC dentin, Duceram LFC incisal, IPS Eris dentin & IPS Eris incisal porcelains were studied. The appearent density of each specimen were measured using Archimedes method and the porosity calculated, each specimens was coupled to standard ceramic tiles using an immersion liquid and the color shade was measured in CIE Y xy coordinates using a tristimulus colorimeter, Translucency was assessed by calculating the contrast ratio of shade value in front of black versus white backgrounds. The powder/liquid ratio did not significantly affect translucency, but porcelain type had a significant effect on translucency.

Alvin G. Wee *et al* (2005) [17] This study was evaluated that the color formulation and reproduction of opaque dental ceramic A total of 25 opaque feldspathic dental ceramic specimens were fabricated by mixing six different shades in different concentrations. The reflectance spectra were measured and the actual CIELAB coordinates were obtained. The CALAB and CAK/S method were used to predict the L*A*B* values with reference to the concentration of the pure shade, both methods produced mean DE*s between the actual and predicted methods. The simpler CALAB method can be used to determine the opaque ceramic mixture for specific shades with accuracy.

Moon soo *et al* (2006) [18] The purpose of this study evaluated the changes in optical properties of enamel porcelain after repeated external staining. Enamel porcelain disks of 1 shade were prepared and 1 of 4 types of external stains was applied over the specimens and fired. Firing was repeated three times after application of the same stains. Color of the specimens before and after staining was measured with a reflection spectrophotometer. Two factors of repeated measure analysis of variance with fixed factors of the stain type and number of staining cycle for the change in CIE L*A*B* color and chroma after repeated staining was performed. Color difference and lightness increases significantly after repeated staining cycle, but chroma changes was small after repeated staining cycle.

Tamer E. Shokry *et al* (2006) [12] The purpose of this study evaluated the effect of core and veneer thicknesses on the color parameters of two all-ceramic systems. Disk specimens 16mm in diameter with core/veneer thickness of 0.8/0.2 were made with leucite reinforced ceramics and thickness of 0.5/0.5 were made from glass infiltrated spinell ceramic. Color parameter L*A*B* of CIELAB color space were measured against a neutral gray background with a tristimulus colorimeter. The color of the ceramic disk specimens is strongly influenced by the core thickness, veneer thickness and also by their interaction.

Frederick *et al* (2007) [19] This study evaluated the Contrast ratio and masking abilities of three types of ceramic veneers. Disk shaped specimens of shade A2 of 3 types of all ceramic systems was fabricated. The contrast ratio is assessed on black background to the illuminance of the same material when it is placed over a white background was determined, it is the ratio of illuminance of the test material. Vitadur Alpha had significantly lower contrast ratio and poor masking ability compared to Procera, Empress 2 & Vitadur alpha. Procera veneers had a significantly higher contrast ratio compared to Empress 2 vitadur alpha.

Jin Soo *et al* (2008) [20] This study evaluated the translucency property in the different ceramics material. The A2 corresponding shade of seven all ceramic core materials and one sintering ceramic as a reference were prepared in clinically relevant thickness. The A2 and A3 corresponding shades of each recommended veneer ceramics were fabricated so that the thickness of the layered specimen over the white and the black background.

The color of core, veneer & layered specimens was measured over white and black backgrounds relative to the illuminants-D_{65}, A and F2 with a reflection spectrophotometer. Under daylight condition translucency of all ceramic materials is lower than those under incandescent or fluorescent lamps. Therefore, the difference should be considered when shade matching translucent shades of all ceramics.

Nicoleta Ilie *et al* (2008) [(21)] This study has evaluated the Correlation between ceramic translucency and polymerization efficiency through ceramics. All these effects were expressed in terms of Vickers hardness measured with an automatic micro hardness indenter on thin luting composite films stored for 24 hrs in distilled water at 37c. The effect on luting composite hardness without an additional chemical catalyst and the following parameter: curing time, ceramic thickness and ceramic translucency, measured using a reflectance spectrophotometer. With minimal curing time maximum hardness is achieved.

Bor-Shiunn Lee *et al* (2008) **[22]** The purpose of the study was to evaluate the development of reproducible in vitro tooth staining model to simulate the intrinsic discoloration of teeth and evaluate the ability of two catalyst to enhance the bleaching activity of H2O2 , Rhodamine B , Orange II, Fe(III) phthalocyanine and tea were used to stain the tooth specimens for 4-72h and subsequently bleached by H2O2 for 4- 72 h. The process was photographed using a digital stereoscopic microscope and digital camera the image was transformed to get L*A*B* values of CIE L a b system with image processing software. The catalytic ability of light irradiation plus addition of Fe/Sodium-Y for specimens stained by orange II was evaluated in test tubes and in extracted tooth model. Orange II was the most appropriate dye for tooth staining among the dye for tooth staining among dyes used in this study, addition of Fe/ sodium-Y or Mn/ sodium-Y and for the specimens stained by Orange II, light irradiation could elevate the bleaching efficacy of H2O2.

Ho-Nam Lim *et al* (2010) **[23]** The purpose of the study was to evaluate the Spectroradiometric measurements showed significantly different translucency for different types of clinically simulated ceramic specimens. Seven A2 shade core ceramics (Slip cast block- In ceram Spinell Blanks, In ceram Alumina blanks, Zirconia Block, Feldspathic Vita block, Heat pressed IPS Empress 2, Sintering VM 7) and A2 and A3 shade veneer ceramics has a thickness of 1.5 mm. The color of core, veneer, and A2- and A3-layered ceramics was measured over white and black backgrounds by an spectroradiometric with 2 measuring apertures of 2.63 and diameter is 5.25. The differences in spectroradiometric (5.25)-based Translucency parameter values of the layered ceramics are evaluated with 2-way ANOVA with the help of fixed factors of shade designation and type of ceramic core (α=.05). Translucency parameter values measured by the spectroradiometric and the spectrophotometric were significantly different but highly correlated.

Isabelle Denry *et al* (2010) [(9)] The technological evolution of ceramics for dental applications has been remarkable, as new materials and processing techniques are steadily being introduced the improvement in both strength and toughness as made it possible to expand the range of indications to long span fixed partial prosthesis, implant abutments and implants.

Hui Wang *et al* (2011) [(24)] The purpose of the study was to evaluate the influence of varied surface texture of dentin porcelain on optical properties. Eighty dentin porcelain (ShoFu Vintage Halo, shade A2) disks (1.0 x 10.0 mm) were fabricated and assigned to 10 groups. The specimens which is dentin porcelain are made up of different surface textures with modified roughness in surface (Ra) and different levels of waviness (Wa). Using spectrophotometer transmittance, reflectance, and CIE L*a*b* values are measured

(PR-650) after standard finishing of the enamel-dentin porcelain complex. Surface texture of dentine porcelain significantly influenced the optical properties of enamel- dentin porcelain specimens, and surface waviness had higher correlation coefficient with optical parameters than did roughness.

Bogna stawarczyk *et al* (2011) [25] The purpose of the study was to evaluate the load bearing capacity and the types of failures in the anterior zirconia crowns in which the veneer has been fabricated by over pressing and layering technique. Standardized zirconia framework were fabricated and randomly divided into 8 groups, Four groups were veneered with one of the layered veneering porcelains: Zirox, GC Initial ZR, VITA VM9 or IPS e.max Ceram and the other four were veneered with over pressed veneering porcelains: PressX Zr, GC Initial LF, VITA PM9 or IPS.E.max ZirPress. The crowns were cemented on their corresponding Co-Cr abutment and the specimens were loaded at an angle of 45degree in a universal testing machine to determine the fracture load. Veneering Porcelain for zirconia frameworks have good fracture load resistance compared with layered porcelain.

Motoaki Ishibe *et al* (2011) [26] Conducted a study to evaluate the shear bond strength between pressed and layered veneering ceramics fabricated in high noble alloy and cores of zirconia. The result shows that there was no significance shear bond strength between pressing and layering ceramics. For shear bond strength of veneering ceramic to zirconia there was no significant difference between the pressed and layered groups.

Wei-Shao Lin *et al* (2012) **[27]** Conducted a study to evaluate the Flexural strength of core and veneering porcelain and fabrication technique by Weibull analysis test on the selected dental ceramics. Leucite-reinforced glass-ceramic cores have lower flexural strength than lithium disilicate ones, while fabrication techniques (heat-pressed or CAD/CAM) and specimen thicknesses do not affect the flexural strength of all glass ceramics. The powder/liquid veneering technique showed lower flexural strength and has increased reliability, with a higher Weibull modulus for zirconia bilayer specimens when compared to heat – pressed veneering technique.

Lisa S. Spink *et al* (2013) **[28]** Conducted a comparative study between absolute and surrogate measures of relative translucency in ceramics by spectrophotometer using14 disk of ceramics with different thickness and chroma. This study resulted that the contrast ratio is not a direct measure of translucency and cannot be used below the 50% of transmission. Non –linear regression was used to compare measurements of absolute versus relative value for each of spectrophotometer.

Fu Wang *et al* (2013) [29] This study concluded that the thickness of the zirconia is inversely proportional to the translucency of the material used. They have also stated that for an improved esthetic, the translucent characteristic of the ceramic material should be well known along with its composition and thickness. The translucency parameters (TP) value for a glass ceramic ranges from 2.0 to 0.6 mm, and for zirconia ceramics it ranges from 1.0 to 0.4 mm which is measured by using spectrophotometer.

Bara Bagis *et al* (2013) [30] Conducted a study to evaluate the optical properties of various ceramic system. It has revealed that the none of the full ceramic systems were able to match the color of the shade guide, each specimen was measured before and after to obtain the L, A, B coordinates and to measure the translucency parameter. As ceramics becomes more opaque, darker, reddish and yellowish due to aging. This study result also revealed that the chemical structure of ceramic system is more important is determining the optical parameters.

Richard Ansong *et al* (2013) [31] They conducted a study to evaluate the fracture toughness of Heat pressed and layered ceramics. The authors have used bar specimens to fabricate 8 different types of ceramics and used single edge notch beam test method with a universal testing machine to record the fracture force values. The study resulted that the mean of the fracture toughness values ranges from 1.20 MPa to 1.74 MPa and it could relate primarily to the processing technique.

Barizon *et al* (2013) [(32)] Conducted a study to evaluate the correlation of contrast ratio and translucency parameter. They have concluded that there is a significant correlation between contrast ratio and translucency parameter. Disks of about 13mm in diameter and 0.7mm in thickness were fabricated using several materials like VITAVM9, VITA PM9, IPS Empress CAD, IPS e.max CAD, IPS e.maxPress and Lava Zirconia, VITA VM9, Lava zirconia.

Kursoglu *et al* (2014) [(33)] This study conducted using a 56 ceramic disc of varying thickness and 7 different groups with a varying veneer thickness (0.2, 0.5, 0.7mm) to investigate the translucency parameter of core veneer thickness. Translucency parameter decreases when the ceramic thickness increase. Hence, total ceramic thickness affects the translucency. If thickness decreases as per parameter values the translucency of core material has more effect than that of veneer material.

Barizon *et al* (2014) [(34)] This study evaluated the degree of translucency with different ceramic systems designed for porcelain veneers. The translucency of a restoration is affected by both thickness and shade of lithium disilicate ceramic. Shade affects translucency parameter less than thickness. Statistically significant differences in the translucency parameter were found among porcelains. VM9 greater than PM9, Empress esthetic greater than Empress CAD greater than MarkII, Everest, e.max CAD greater than e. max press greater than Lava. Significant difference was noted when different shades and thickness were confirmed.

Neelam Pande *et al* (2015) [35] The pressable all-ceramic system was used in this study for shade reproduction using a color measurement spectrophotometer on unstained and stained natural maxillary central incisor. Comparing shade reproduction in unstained teeth with low -translucency and medium opacity; medium translucency and high opacity on stained tooth. Fabrication of the restoration for unstained natural tooth produces best shade reproduction using All-ceramic low translucency material. For a better esthetics medium opacity is an important material for the fabrication of restoration on both unstained and stained natural teeth. In clinically using a high opacity material is difficult on stained tooth as it gives different shade reproduction.

Jeong *et al* (2015) [36] Conducted an in vitro study to evaluate the translucency of pressable ceramics with different core and veneer thicknesses, Specimens were grouped based on core + veneer thickness into three groups; 1+0.5mm, 0.7+0.8 mm and 0.5 + 1mm, Studies have shown that luminous transmittance value of pressable ceramics and the thickness of core veneer combination exhibits a statistically significant dependence on both type. They concluded that major factor in determining the translucency of zirconia is the thickness of the restoration.

Ahed Al-Wahadni *et al* (2016) [(2)] ***Conducted*** an in vitro study that evaluated the shade reproducibility of veneered zirconia restoration in artificial tooth. In this study CAD/CAM technology was used to scan the prepared tooth for 45 cobalt chromium dies. They used only one Co-Cr die for scanning and all 45 zirconia coping was milled and divided into 15 specimens for each group according to the veneering technique they are digital veneering, layering veneering and over pressing veneering . They used A2 shade for all three groups. The specimens were cemented onto the dies using glass ionomer cement. The color shade for Vita A2 shade tab was measured using a spectrophotometer. As per shade reproducibility layered veneering group is superior to other groups in each specimen.

Farhad Tabatabaian *et al* (2017) [(37)] conducted an in vitro study that evaluated the effect of thickness of zirconia on its masking ability and to define a correct thickness of zirconia ceramic as a coping material. Nine groups of following thickness of zirconia disc specimens were used in this study such as 0.4 mm, 0.6 mm, 0.8 mm, 1 mm, 1.2 mm, 1.4 mm, 1.6 mm, 1.8 mm, and 2 mm each containing 10 specimens.

These disc specimens were placed in white and black substrate and analyzed using spectrophotometric measurements. They concluded that ideal masking ability of zirconia ceramics was obtained with a minimum thickness of 1.6mm and clinical masking ability was obtained with 1mm.

Esra Al juaila *et al* (2018) **[38]** Conducted an invitro study to compare translucency of esthetic zirconia ceramic with conventional ceramics. Using 6 different types of ceramics with three varying thickness. In this study 144 zirconia samples were prepared and divided into 6 main groups based on materials, and based on thickness they are sub grouped into 3. Using spectrophotometer each disc has been tested. They concluded that glass ceramics showed higher Translucency Parameter value than crystalline based ceramics.

MATERIALS AND METHODS

The present in-vitro study is conducted for the evaluation of masking ability of zirconia based ceramics with different core and veneer thickness.

The following materials, instruments and equipment are used for the study.

MATERIALS USED

1. Zirconia blank (Zenostar, Ivoclar Vivadent, USA)
2. Pressable glass ceramics- IPS Emax ingot (Ivoclar Vivadent, USA)
3. Feldspathic Porcelain (Vita VMK master)
4. Rhodamine B stain (Sigma Aldrich Co., St Louis, USA)
5. Orange II stain (Sigma Aldrich Co., St Louis, USA)
6. Alizarine red stain
7. Povidone
8. Tea
9. Distilled water

EQUIPMENTS USED IN THIS STUDY

VITA easy shade compact dental spectrophotometer

METHODOLOGY

Sample size:

Total number of sample were 45

Samples were divided into three experimental groups with 15 samples

Three groups with different thickness categorized

Group 1 = 0.5 + 1mm

Group 2 = 0.6 + 0.9mm

Group 3= 0.7 + 0.8mm with variant color groups

Six Groups of Test Solution:

Group A - Rhodamine B

Group B- Orange II

Group C - Alizarin Red

Group D - Tea

Group E - Cool drinks

Group F - Povidone

FABRICATION OF ALL CERAMIC CORES

A Total of 45 ceramic disk specimen (N=15) was prepared that are zirconia core with a ceramic veneer. Specimens are grouped based on their core + veneer thicknesses: 0.5+1 mm, 0.6+0.9mm and 0.7+0.8 mm is shown in Figure 1 and 2. All specimens were undergone surface grinding, polishing to obtain proper thickness and translucency before evaluation. Two specimens taken without unveneered surface with zirconia core and veneered porcelain without zirconia core where taken as control for the study.

To achieve the required consistency and to eliminate the variant degree of roughness on the translucency, scanning profiler was used to analyze the surface roughness of each specimen to make all specimens in a uniform surface and the consistency was verified through statistical analysis. Spectrophotometer is the device that was used to determine the luminous of transmittance of the specimens.(39) It was used to access the thickness of the core veneer and also to access the effects of the ceramic type.

To produce the specimen, a zirconia blank was milled using computer-aided design and computer-aided manufacturing (CAD/CAM) and the milled zirconia core was then fired according to the manufacturer's instructions. To apply the veneer on the zirconia core, a wax block was milled using CAD/CAM and a wax veneer was subsequently attached to the zirconia core before it was invested and eliminated. The all ceramic system with the varying in thickness of core lithium disilicate reinforced ceramic [20]

SAMPLE COLLECTION & EVALUATION OF CERAMIC DISC ON TEETH

The surfaces of the specimens were ground while wet on 240-, 400-, 600-, 800-, and 1200-grit silicon carbide paper. While the specimens were being ground, their thicknesses were measured frequently with a digital micrometer and they were ultimately ground to a thickness of 1.5 ±0.01 mm. All the produced specimens were cleaned in an ultrasonic cleaner for 180 seconds to remove any residue.

To measure the surface roughness of each specimen, a scanning profiler with a stylus was used. The stylus was placed at the center of the specimen surface and the average roughness was calculated by measuring the roughness across a 5-mm length at a speed of 0.1 mm/s. For the quantitative analysis of the luminous transmittance, a spectrophotometer with a dual-beam system was used. Measurements were performed in the VITA easy shade compact dental spectrophotometer is shown in fig 9 with day light source [36]

The extracted maxillary central incisor natural tooth with all the surface intact is used for the evaluation of ceramic discs. The teeth were preserved in 5% normal saline solution at room temperature prior to the staining process. ISO Standardization ISO NO: 7491: 1983 (Determination of color stability).

STAINING THE TEETH

Staining the natural teeth by immersing it in cool drinks for up to 72 hrs(GROUP-E).Immersing it in Povidone Iodine and evaluated (GROUP –F). Boiled 2gm of tea in 100ml of distilled water for 5min then immersed teeth (GROUP-D) for 72 hrs stains are up taken. Stain process was monitored at 4, 24, 48, 72 hrs after immersion and the color of the tooth specimens was simultaneously evaluated at the same time period.

1 gm of Rhodamine dye (GROUP-A) was diluted in 10 ml of distilled water and teeth were immersed in it for 72 Hrs . Stains were up taken and stain process was monitored at 4, 24, 48, 72 hrs after immersion and the color of the tooth specimens was simultaneously evaluated is shown in Figure 7.Teeth are immersed in Orange II (GROUP-B) and evaluated same manner, teeth were immersed in Alizarin red (GROUP-C) is shown in Figure 4,5 and 6 are evaluated [22]

MOUNTING THE TEETH IN ACRYLIC BLOCK

The selected natural teeth have been stored in saline for 24 hrs prior to procedure to remove all the debris, calculus and extrinsic stains. The teeth are then removed from the saline washed thoroughly in running tap water, polished with polishing brush and polishing paste using contrangle hand piece.[40] Unstained normal natural teeth with zirconia veneered with ceramic was taken as the control.

The treated extracted natural teeth are dried and then mounted on a wax sheet to prepare a wax pattern for the fabrication of acrylic block to mount the natural teeth, wax pattern is then flasked, dewaxing procedure is done and then packed with self-cure acrylic resin (DPI) by placing the long axis of the tooth perpendicular to the horizontal plane.

The teeth are then mounted on the acrylic block, in such a way that the portion of the teeth above cement-enamel junction is exposed for the preparation of the labial surface of both unstained and stained teeth. The acrylic block is then finished and polished with required measurements.

PREPARATION OF TOOTH FOR RECEIVING ALL CERAMIC PRESSABLE LITHIUM DISILICATE DISCS

During evaluation of the specimen by using spectrophotometer, which has a small aperture usually results in inadequate reading of the lightness. The inadequate reading of the lightness is due to the reduction in the illumination and the collection of light source. The Edge loss effect present in the natural teeth will have a negative impact on the reflected light from the spectrophotometer. To avoid such errors ceramic discs should be flat. The labial surface of both unstained and stained tooth should be prepared up to 1 mm for placing the discs. (41)

PREPARATION OF MOLD FOR STANDARDIZATION OF THE ALL CERAMIC DISCS

Fabrication of Zirconia discs using Ceramill CAD/CAM machine:

In the present study, the Zirconia discs are fabricated using the Ceramill system (AMANN GIRRBACH, Ceramill MOTION 2). It consists of a scanning system (Ceramill map 300 work station), a CAD software (Ceramill mind CAD), a CAM machining system (Ceramill CAM) and a sintering furnace (Sintering furnace Ceramill Therm furnace).

The material used in the present study is partially sintered Zirconia (zenostar) which has got high strength and rigidity. The process of obtaining the Zirconia discs is described in detail below.

a) Stainless steel mold -Model transfer: Before the mold is scanned, it is essential that proper orientation of the mold is shown in Figure 3 and the scanner is achieved in order to capture all the details of the preparation.
b) Scanning the die: Ceramill map 300 work station is used for scanning the mold. The scanning process is then activated. The scan details are fed into the Ceramill mind software for further designing of the discs. The time taken to scan each die is approximately 4minutes.
c) Designing of Zirconia discs: The Ceramill mind CAD software is used for the virtual designing of the discs. The scanned image of the disc is visualized on the screen of the Ceramill work station and the disc is designed to adapt to the contours of the scanned image. Usually a Zirconia onlay design is selected from the library of predesigned formats available in the software. This predesigned pattern is altered virtually on the screen to match the coordinates on the scanned image so that an accurately fitting disc for that particular mold space is obtained. The thickness of the Zirconia disc is set uniformly as 2mm throughout. This design can be stored and transferred to the Wieland milling unit

using a special software called as Ceramill match. Successive Zirconia discs are thus designed and stored. The number of Zirconia disc that can be milled from a single blank depends on the size of the blank and the number of designed Zirconia discs to be fed for milling in a single batch is determined accordingly. The whole process of designing of each Zirconia disc takes approximately 15min. The order button integrated in the program transfers the construction data from the designing unit to the milling unit (CAM).[(42)]

d) Computer aided machining (CAM) of zirconia discs: The Zirconia material used in the present study is Zenostar Zi which features high strength, rigidity and biocompatibility. These pre-sintered Zirconia blanks can be easily processed as they do not splitter and provide optimum edge stability. The milling process begins with the selection of appropriate size of the blank. In this study two 14mm blanks are used. The blank is screwed to a retaining plate and the retaining plate is mounted into the milling machine (Ceramill motion). Each Zenostar Zi blank is provided with a batch-specific coding which has a matching enlargement factor. This compensates for the volumetric shrinkage that occurs during sintering. The milling of each Zirconia disc takes approximately 15 to 16 minutes. Zirconia disc are milled in a similar manner and are subjected to sintering.

e) Sintering of Zirconia discs: The Sintering furnace Ceramill Therm (Amanngirrbach) furnace is used for the sintering the zirconium disc. The milled Zirconia discs are placed for sintering into the sintering bowl filled with sintering pearls.

To ensure proper support, the disc were placed with the slight pressure on to the sintering pearls and final sintering is performed by heating the furnace from room temperature to final temperature of 1450^{0}C at a heating rate of 5-10 k/min. The dwell time at final temperature is 2hrs and the blanks are cooled from final temperature of 1450^{0}C to room temperature (at least <200^{0}C) at a rate of approximately 5k/minute over a period of 5hrs. After final sintering the Zirconia disc are reworked with water cooled lab turbine and ground using diamond points [43]. The cores are fabricated from the ceramic ingots, two veneering material as per the instruction given in the manufacturer's description.

SPECTROPHOTOMETRIC EVALUATION

The difference in the color is usually evaluated by the two methods: namely the perceptional method and the instrumental measuring method. Among these two methods the perceptional is most frequently used method for the fabrication of the indirect restoration. The perception method depends on the presence of cones in the human eye for the color perception. The human color perception may lead to subjective error which could vary from a person to person. Apart from that, the intensity of the color matching is also determined by many factors such as the light source, surrounding light condition, size of the objects, background of which the color is matched, fatigue of the observer eye, illumination for the light source, color characteristics of light source. The shade guide which is usually used to determine the color matching will also result in subjective error. [35]

Human color evaluations are subjected to perceptual errors. The color evaluation is usually measured at the center of each specimen with suitable back ground. White or black color is usually preferred back grounds. A standard glossy white calibration plate was used to validate the reliability of the instrument, before and after each series of measurements for each group The light within the specimen get scattered to the edge without being absorbed is called edge loss effect. [44] In order to avoid the entrapment of air between the two disk, a drop of water is placed between the two disk specimen for an optimum contact angle. The color assessment is usually done by using an instrument called spectrophotometer or colorimeter. The time taken for measuring the color is usually l.5 s (unit data output), the minimum-interval time during day hours is 4 seconds.

The color measurements of the zirconia disk samples examined using the VITA easy shade compact dental spectrophotometer to obtain the mean ‘l’, ‘a’, ‘b’ values CIELAB units, have been used for color quantification when analyzed mathematically to compare the color parameters of different objects. In this system, the color space consists of three coordinates L*, a* and b*. [(45)] The L* refers to the lightness coordinate, the value ranges from 0 – 100 .0 refers perfect black and 100 refers perfect white. The a* and b* are the chromaticity coordinates, in red−green axis and yellow–blue axis. Positive a* values indicates red color and negative values indicates green color. Similarly, positive b* values indicates yellow color while negative values indicate the blue color is shown in Figure 8. [(45)]

The data are automatically stored. Color variant from a target color can be evaluated and immediately displayed in a numerical form or on a spectral reflectance graph. Prior to the evaluation of each sample disk the spectrophotometer is subjected to calibrate against standard black and white backgrounds is shown in Figure 10. The beam of the spectrophotometer is directed towards sample disks which is placed on the labial surface of the stained/unstained natural tooth The coordinates of each disc are measured using CIELAB system in the form of L* a* b* values is shown in Figure 11. [(35)]

To obtain the mean value, an average of three different readings are marked for each respective disc Δ E formula is used to measure the color change Shade reproduction is compared and measured between the control and the specimen:

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

where Δ E* is the change in color and Δ L*, Δ a*, Δ b* represent the difference in L*, a*, b* values of the control and the ceramic discs.

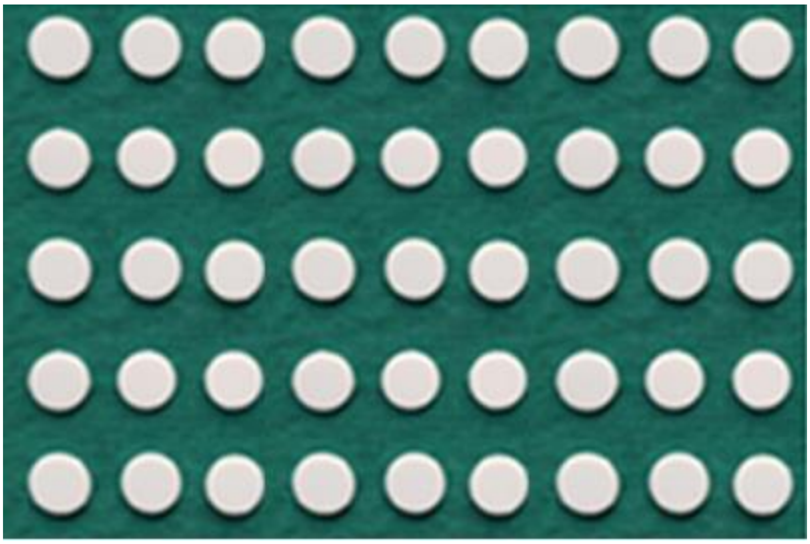


Figure 1: Sample Disc

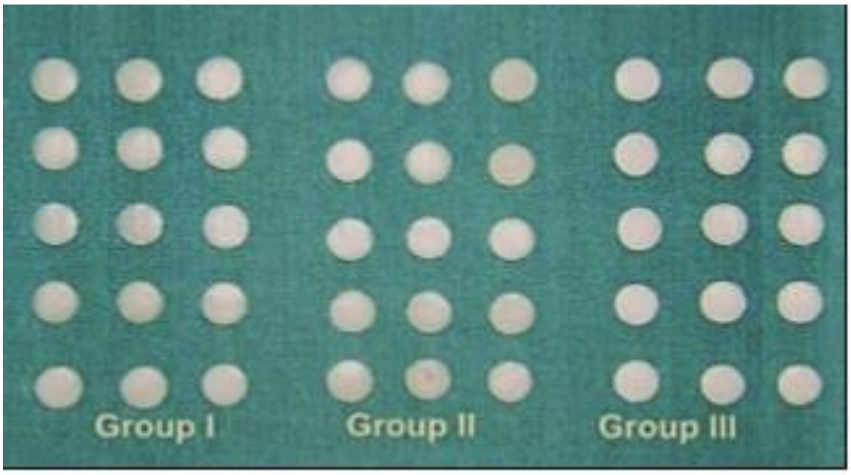


Figure 2: Grouping of sample disc

Figure 3: Metal mold

Figure 4: Rhodamine B dye **Figure 5** :Alizarin Red **Figure 6:** Orange II

Figure 7: Stained teeth

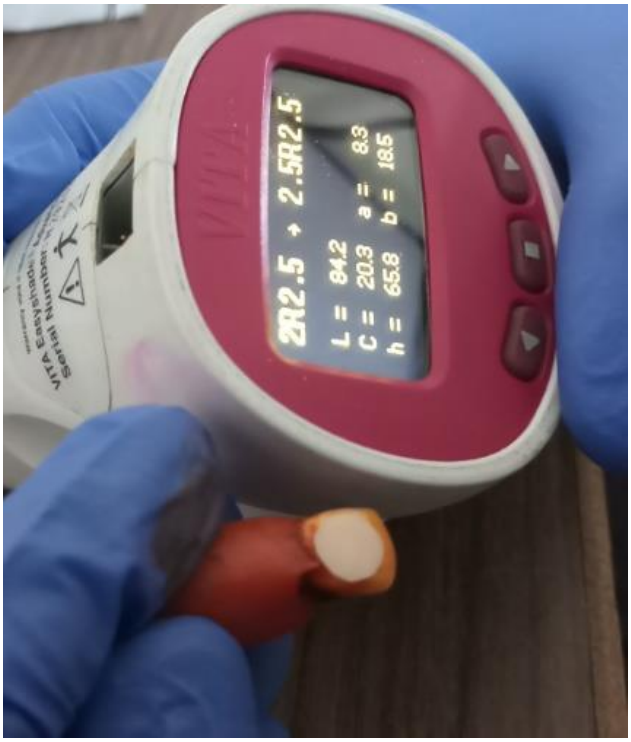


Figure 8: Reading obtained from spectrophotometer for samples in tested solution

Figure 9: Vita easy shade guide

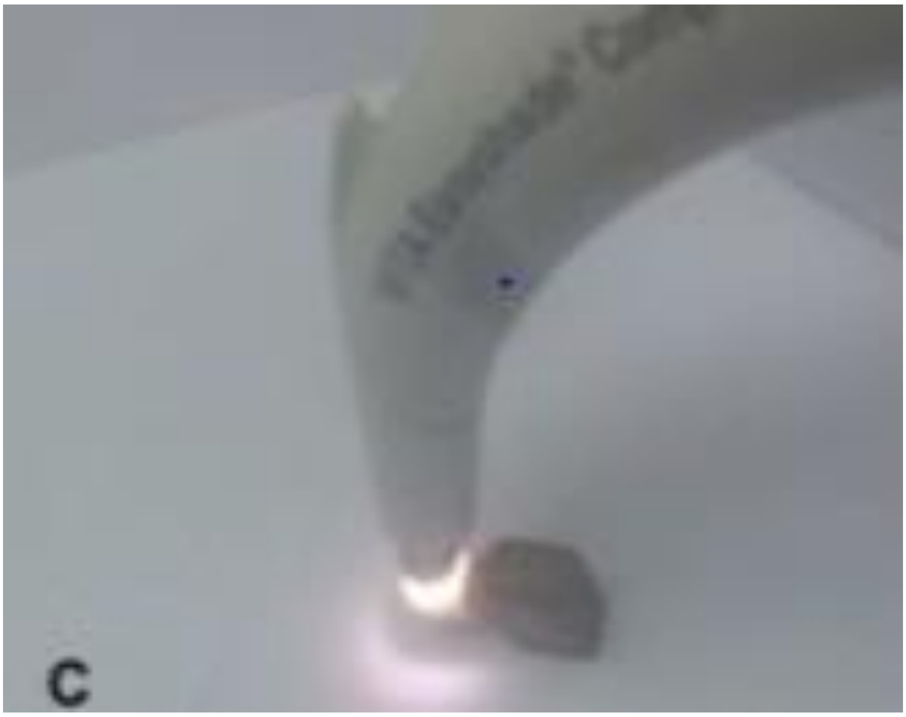


Figure 10: Analysis of specimen

Figure 11: Reading Obtained from spectrophotometer for core specimen

RESULTS

Comparing Translucency for 45 zirconia discs specimen with three (N=15) different thickness considering ΔE value & Translucency parameter

Three groups with different thickness categorized

Group 1 = 0.5 + 1mm,

Group 2 = 0.6 + 0.9mm

Group 3= 0.7 + 0.8mm with variant color groups

Six groups of test solutions

Group A - Rhodamine B,

Group B - Orange II,

Group C - Alizarin Red,

Group D - Tea,

Group E - Cool drinks,

Group F – Povidone.

The mean and standard deviation for ΔE value of three different thickness groups of zirconia disc was shown in table 1, Among these three groups Group 1 shows statistically significant p value of 0.000, with a mean value of 7.630. Chart 1 represents the mean and standard deviation value of ΔE and translucency parameter of three groups of zirconia disc with different thickness. Table 2 shows the output of the ANOVA analysis and reveals that there is a statistically significant difference between the mean of the three groups. From the above results, the ΔE value is 0.000 which is below 0.05 confidence interval and therefore, there is a statistically significant difference in the mean of the three different thickness of the core. Though the p value of all the three variables shown in table 2 (ΔE, L and B) are statistically significant to determine which specific group differs, the multiple comparison table was done using the Anova & Tukey post hoc test.

In Table 3 ANOVA and Post Hoc Tukey Test was performed to evaluate significant difference between the three study groups. Post Hoc tukey tests analysis showed that among the three groups the Δ E value for Group 1 and 3 and Group 2 & 3 had statistically significant p value. The p value for Group 1 is superior to Group 3 ($p<0.05$). Which the translucency parameter comparison does not reveal any statistically significant.

In Table 4 mean and standard deviation of all three thickness in six group of test solution was tabulated, the test results for ΔE showed that there were statistically significant results for the following samples;

- Group B (ΔE has a p value =.012) Group C (ΔE has a p value =.027) and Group D (ΔE has a p value =.004). The other samples were not statistically significant namely Group A, Group E & Group F.

- Chart 2 shows the core translucency of six groups of test solution in three groups.
- Chart 3 shows mean and standard deviation of all three thickness in six group of test solution.

The test results for translucency parameter in table 4 showed there was statistically significant results for the following samples;

- Group A Translucency Parameter has a p value =.005
- Group C Translucency Parameter has a p value =.035
- Group F Translucency Parameter has a p value =.015.

There was no statistically significant difference among the other three groups of test solution (Group B, Group D & Group E).

ANOVA test with post hoc tukey test was run in table 4 to determine statistical significant values between the three study groups for ∆E and Translucency parameter.

The results of ∆E values were shown in Table 5 the statistical significant results among them.

- In the Group B the ∆ E value was significant difference among the 2 and 3 group with a p value of 0.013.
- In the Group C the ∆ E value was significant difference among the 1 and 2 group with a p value of 0.038
- In the Group D the ∆ E value was significant difference among the 1 and 3 groups with p value of 0.013.

The results of Translucency parameter values were tabulated in table 6 Post Hoc tukey tests analysis was done to find out due to which group among the comparisons the statistical significant difference was achieved.

- In the Group A Translucency Parameter there was significant difference among the 1 and 2 group with a p value of 0.006.
- In the Group C Translucency Parameter there was significant difference among the 1 and 3 group with a p value of 0.033.
- In the Group F Translucency Parameter group there was significant difference among the 1 and 3 group with p value of 0.011.

TABLES AND CHARTS

Table 1: Shows ∆E value of three thickness groups of zirconia disc

SI NO	GROUP 1	GROUP 2	GROUP 3
1.	7.4	6.8	7.4
2.	7.7	6.3	7.7
3.	6.4	7	6.4
4.	8.4	8.6	8.4
5.	6.4	9.5	6.4
6.	10.2	6.4	10.2
7.	6.7	6.7	6.7
8.	7.4	7.4	7.4
9.	5.7	8.4	5.7
10.	6.4	6.4	6.4
11.	11	5.6	11
12.	5.5	5.5	5.5
13.	6.3	6.3	6.3
14.	6.0	6.0	6.0
15.	9.5	9.0	9.5
MEAN±S.D	7.630 ± 1.7557	7.350 ± 1.1078	4.810 ± 1.0775

Table 2: Mean and standard deviation of the ΔE value and translucency parameter of three groups of zirconia disc with different thickness

	GROUP 1		GROUP 2		GROUP 3		F Value	P Value
	Mean	S.D	Mean	S.D	Mean	S.D		
Δ E	7.630	1.755	7.350	1.107	4.810	1.077	13.237	0.000
L	4.640	3.001	4.950	1.784	1.090	0.753	10.816	0.000
A	3.00	1.839	1.450	0.883	2.360	0.944	3.599	0.041
B	16.85	1.408	17.08	1.34	10.43	1.396	74.612	0.000
TP	102.96	66.54	82.09	13.34	44.39	34.81	4.543	0.020

Table 3: Comparison between all three groups of zirconia disc with different thickness:

	GROUP 1 &2		GROUP 2 &3		GROUP 1 & 3	
	Mean	Sig	Mean	Sig	Mean	Sig
Δ E	±0.280	0.899	±2.54	0.001	±2.82	0.00
L	±0.310	0.940	±3.86	0.001	±3.55	0.002
A	±1.55	0.033	±0.91	0.27	±0.64	0.521
B	±0.23	0.927	±6.65	0.00	±6.42	0.000
TP	±20.8	0.547	±37.7	0.154	±58.5	0.016

Table 4: Mean and standard deviation of all groups of test solution among the three groups of disc

	GROUP A			GROUP B			GROUP C			GROUP D			GROUP E			GROUP F		
	Mean	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**
GROUP 1 ΔE	6.81	0.47	0.552	12.2	1.21	**0.012**	7.42	1.1	**0.27**	10	2.07	**0.004**	10.8	1.45	0.085	6.33	1.27	0.051
GROUP 1 TP	34.1	24.4	**0.005**	46	18.4	0.185	62.2	19	**0.35**	98.8	35.6	0.52	22.8	14.7	0.107	21.92	16.0	**0.015**
GROUP 2 ΔE	6.4	2.0	0.552	12.8	1.93	**0.012**	5.4	1.5	**0.27**	7.4	0.51	**0.004**	10.1	1.59	0.085	4.4	1.83	0.051
GROUP 2 TP	80.9	43.5	**0.005**	49.9	21.8	0.185	77	46.1	**0.35**	72.4	86.6	0.52	22.4	14.5	0.107	43.7	25.4	**0.015**
GROUP 3 ΔE	7.18	1.7	0.552	10.5	1.79	**0.012**	7.2	2.34	**0.27**	7.57	2.29	**0.004**	8.77	2.78	0.085	5.39	1.83	0.051
GROUP 3 TP	74.4	20.1	**0.005**	69.2	40.8	0.185	118	63	**0.35**	102	58	0.52	38.8	25.3	0.107	73.9	57	**0.015**

Table 5: Comparison of ∆E values of all six groups of test solution among the three groups of disc:

DELTA E	***GROUP 1&2***		***GROUP 2 &3***		***GROUP 1&3***	
	Mean	***Sig***	***Mean***	***Sig***	***Mean***	***Sig***
GROUP A	±0.41	0.832	±0.78	0.521	-0.37	0.861
GROUP B	±0.52	0.769	±2.30	**0.013**	+1.78	0.062
GROUP C	±2.02	**0.038**	±0.84	0.063	-0.18	0.971
GROUP D	±2.66	0.008	±0.17	0.976	+2.49	**0.013**
GROUP E	±0.76	0.684	±1.33	0.324	±2.09	0.073
GROUP F	±1.93	0.040	±0.99	0.394	±0.94	0.430

Table 6: Comparison translucency parameter for the six groups of test solution among the three groups of discs.

Translucency P	**GROUP 1 & 2**		**GROUP 2 &3**		**GROUP 1&3**	
	Mean	**Sig**	**Mean**	**Sig**	**Mean**	**Sig**
GROUP A	±46.7	**0.006**	±6.5	0.887	±40.2	0.020
GROUP B	±3.32	0.964	±3.32	0.307	±22.6	0.203
GROUP C	±15.64	0.737	±40.1	0.152	±55.7	**0.033**
GROUP D	±25.68	0.646	±30.2	0.546	±4.6	0.986
GROUP E	±0.49	0.998	±16.4	0.147	±15.9	0.163
GROUP F	±21.7	0.404	±30.2	0.183	±52.0	**0.011**

Chart 1: This chart represents mean and standard deviation of zirconia core disc with different thickness combination

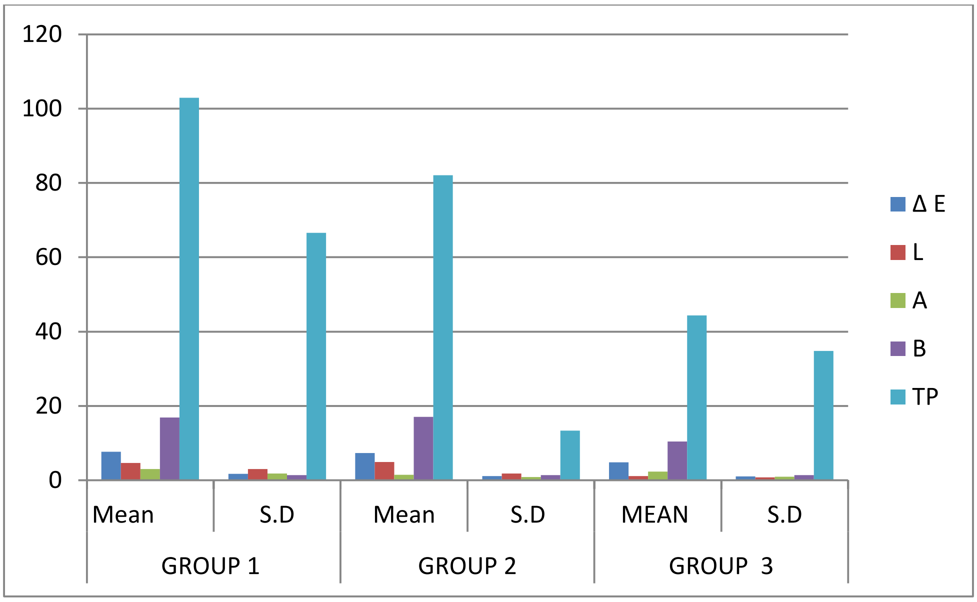


Chart 2: This Chart represents the core translucency for six groups of test solution in three groups

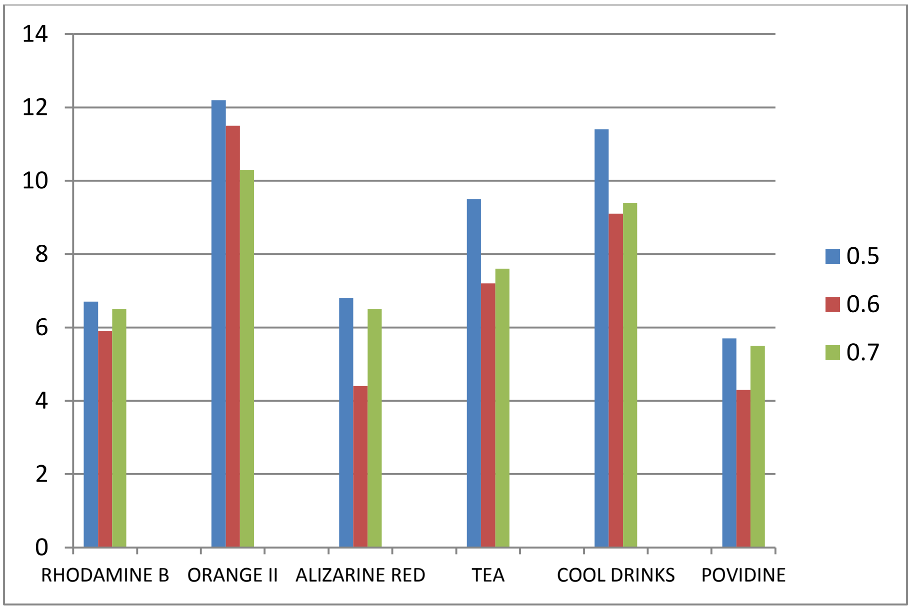
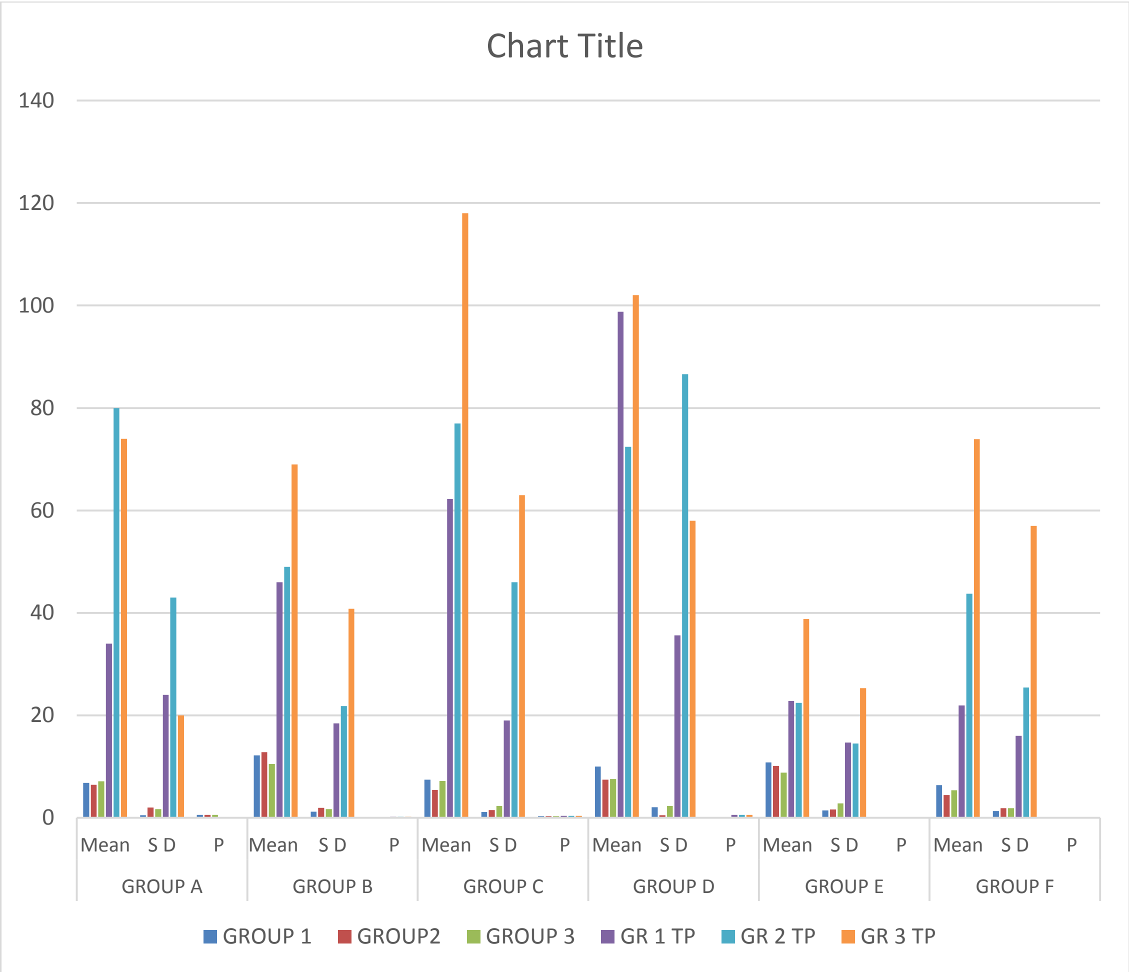


Chart 3: This chart represents mean and standard deviation of all three thickness in six groups of test solution



DISCUSSION

To achieve optimized esthetics in zirconia- based restorations, it is necessary to predict the optical behavior of all ceramics. In an in vitro study, Wang *et al* [14] evaluated the Translucency parameter of some dental ceramics and found some degrees of translucency in zirconia ceramics, which were less sensitive to thickness than glass ceramics.

Both material and thickness influence the Translucency parameter, while an increase in the thickness decreased the Translucency parameter. [24] Wang et al suggested that there exists an exponential relationship between the Translucency parameter and the thickness. The same relationship between the thickness and Δ E was derived from the present study. Both the studies found that there is a similar exponential formula, though there was a slight difference in the co efficient of determination. This may be due to the difference in the tested zirconia ceramics. Regarding the masking ability, the current study evaluated a wider range of thickness than Wang *et al'* study. Additionally, it has represented a clinical thickness cutoff to eliminate the substrate's effect. Peixoto *et al* [47], investigated the effects of shade and thickness of a feldspathic veneer porcelain on light transmission, and suggested that there is a linear correlation between the naperian logarithm of the transmission coefficient and the porcelain thickness.

This suggested correlation can be changed by a mathematical transformation of the correlation equation to an exponential expression. Therefore, the basis of the formula presented by Peixoto *et al* was confirmed by the present research, despite the fundamental differences between feldspathic porcelains and zirconia ceramics.**[48]**

Peixoto *et al* evaluated the translucency of 0.3- and 0.5-mm-thick zirconia copings in comparison with a lithium disilicate glass ceramic, and reported that the investigated zirconia copings had different levels of translucency. The 0.3-mm-thick Lava zirconia coping showed more translucency value (71.7%) than the 0.5-mm-thick Lava zirconia coping (63.9%). This was supported by the current study, which assessed an increase in masking ability as a result of an increase in thickness.

Spyropoulou *et al* **[49]**, **s**urveyed the translucency of the three Procera shaded zirconia coping materials, and found that the differences in translucency between the light and intense shades, the medium and intense shades. While the current research evaluated a shade A zirconia coping, both studies have demonstrated a shift in the optical property of zirconia after structural or dimensional changes.

Suputtamongkol *et al* in an in vivo study have evaluated the color of posterior zirconia –based crowns before and after cementation on metal posts and cores, pre-fabricated posts and composite cores. The Zirconia coping thicknesses of 0.4 to 1mm were used. No difference was reported between the two examined substrates in L*, a*, and b * values; however, a slight change was observed in ∆E values from 1.2 to 3.1. Increase of the zirconia coping thickness from 0.4 to 0.8 mm decreases the ∆ E value significantly, while there was no difference between 0.8 and 1 mm coping thicknesses in this respect. (7) It was concluded that the color of a back ground could impact the final color of the zirconia restorations with the clinically recommended zirconia coping thicknesses.

It was advised that due to the compromised masking ability of the thin zirconia coping (0.4 mm), a tooth-colored core material should be used to avoid the perceptible dark shadow of the restoration. The result of the current study on 0.4-mm thick zirconia copings was consistent with Suputtamongkol *et al* research, although the consequences for the 0.6 and 0.8 mm coping thicknesses were dissimilar. According to the present study, 0.4 to 0.8 mm zirconia coping thicknesses could not provide a sufficient masking ability, however using un veneered zirconia copings and different substrates in the current investigation may be reasons for the result dissimilarity.

A study conducted on the translucency of zirconia-based crowns with 0.3- and 0.5-mm-thick Lava zirconia copings by Kumagai *et al* (50) revealed that at the cervical area there was a significant difference between the coping thicknesses in the Δ E value, while at the body area, results were borderline on the coping thickness, and there was a significant difference between restoration shades in the ΔE value. The present research confirmed the results given by Kumagai *et al*, in which a decrease in the zirconia coping thickness could negatively affect its masking ability; however, this effect was evaluated in a wider range of thickness by this study than the study of Kumagai *et al*. Oh and Kim (51) In which he has demonstrated that the effects of ceramic thickness, abutment shade, and type of coping were significant on the final color of 1- and 1.5-mm-thick zirconia-based restorations with 0.4-mm-thick zirconia copings.

In this present study three different core, veneer thickness have been compared to evaluate the translucency of zirconia with thickness of about 0.5mm, 0.6mm, 0.7mm with subgroup of six groups of test solution.

They concluded that the Lava crowns on a gold alloy post and core might not be color matched with the adjacent teeth. Though the masking ability of different thicknesses of un veneered zirconia was assessed in the present study, a similar result was obtained on the color masking disability of 0.4-mm-thick zirconia coping. Evaluation of the masking ability of veneered and un veneered zirconia by Choi and Razzoog [8] disclosed that 0.4-mm-thick zirconia coping specimens had a high degree of masking ability on black, white, gray, and tooth-colored substrates.

According to Choi and Razzoog's results, measured Δ E values were greater than the perceptional threshold, which showed the limited masking of those coping specimens. Despite a methodological difference in measuring the ΔE between the Choi and Razzoog study (comparing each specimen on a substrate with the same substrate alone) and the present study (comparing each specimen on a substrate with the same specimen on another substrate), both the studies predicted the possibility of a color mismatch when using 0.4-mm-thick zirconia copings. In a recent study performed by Malkondu *et al* [52] on the color of 0.6-and 0.8-mm-thick monolithic zirconia, cement type and zirconia thickness were recognized effective factors.

Despite the optical difference of monolithic zirconia and veneered zirconia in light transmission percentage, the researchers' result on the thickness was supported by the current research. Chang *et al* revealed that luting cements could create perceptible color differences in zirconia crowns, especially at the cervical area. This showed the effect of underlying materials, cements, or substrates, on the color of zirconia restorations, and the importance of definition of a thickness cutoff for a zirconia coping to rule out the substrate impact, which was remarked on in the current investigation.

Various studies have evaluated that the color of zirconia based restorations and multiple affecting factors includes: substrate cement zirconia coping, and veneering porcelain. Additionally, elements that impact each factor also includes brand, thickness, shade and laboratory technique. [(53)]

Some formulas have been suggested to assess the color change based on a variable like thickness. Though these formulas can aid investigators to predict color outcomes, they are less applicable clinically. Therefore, an introduction of a cutoff for a variable, if possible, may be more practical for clinicians to gain predictable and acceptable color results. In this regard, two coping thickness cutoffs for a zirconia ceramic were defined to eliminate the substrate impact on the color of zirconia – based restorations.

According to the CIE Lab color system, white and black colors represent the highest (close to 100) and the lowest (close to 0) L* values on the center axis, respectively. Thus, these colors can reasonably create the most possible ΔE color difference. If a zirconia ceramic with a specific thickness makes no perceptible color difference when being placed on a white substrate and a black substrate, it will rationally mask all the substrate colors like a metal alloy.

Consequently, the 1-mm-thickness cutoff and the 1.5mm thickness cutoff were determined for the tested ceramic in this study, to attain acceptable clinical masking ability, and ideal masking ability, respectively. This means that a zirconia coping with a 1-mm minimum thickness can mask its back ground regardless of the substrate’s color and the veneering procedure. Therefore, it is clinically indicated to heed this cutoff for zirconia-based restorations in substrate affected cases.

Considering a zirconia coping thickness of 0.5 mm and a total thickness of 1.5 to 2 mm for a zirconia-based restoration in a normal case, a 0.5-mm extra space is required for a zirconia coping in a substrate-affected case. This space is practically provided by a further reduction of the substrate during preparation, and subsequently a CAD/CAM zirconia coping with a 1-mm minimum thickness can be prepared.

IMPORTANCE AND ADVANTAGES OF ZIRCONIA RESTORATIVE MATERIAL

A zirconia coping provides high strength, while a veneering porcelain creates a natural appearance for these restorations. Additionally, a zirconia coping manifests a nonmetallic margin because of the natural white color of zirconia ceramic. [3] A 1-mm-thick zirconia ceramic as a coping material demonstrates an approximately 37% visible light transmittance, and therefore zirconia ceramic is called a semi translucent material. [5]

This optical property of zirconia restorations helps clinicians to achieve better esthetic results than with metal-ceramic restorations. On the other hand, translucency of a ceramic material is not always a proper optical characteristic, especially in cases with a metal post and core, a discolored substrate, or a titanium implant abutment. In such a clinical condition, color masking ability of the restoration should be rationally considered. Regarding the optical properties of zirconia ceramics and the light transmission through their structures, a discolored substrate may affect the final color of zirconia-based restorations. This may be precipitated by the compromised masking ability of a zirconia coping or an insufficient veneering porcelain. [8]

Milling techniques were used in production of Zirconia based CAD/CAM reconstruction. They have the potential to substitute the metal ceramic fixed dental prosthesis due to their high biocompatibility and similar mechanical properties with those of metal ceramics. Zirconia is used in posterior FPDs due to their mechanical properties and it permits a considerable amount of reduction in core thickness [(2)]

The crystallographic form of unalloyed zirconia will be influenced by the temperature under ambient pressure. The occurrence of crack is more frequent in zirconia. More amount of compressive stress are seen at the tip of the crack. To avoid the accumulation of crack in the zirconia the toughness of the material has to be increased. There seems to be a significant change in the substructure of the material on extreme temperatures, when the material is heated from the room temperature to 1170^0c crystallographic structure of the zirconia is converted to monoclinic form. When the temperature increases from 1170^0c to 2370^0c the monoclinic form is transformed to tetragonal form. The structure further transforms to a cubic when the temperature change from 2370^0c to melting point.

The volume of the material increases progressively of about 4.5%, when the transformation occurs from tetragonal phase to a monoclinic phase upon cooling leading to a castrophic failure. Therefore, oxides of CaO, MgO, Y_2O_3 or CeO_2 to zirconia-alloys are incorporated to prevent the transformation of tetragonal to a monoclinic phase.

The size of the grain particles, zirconia particle size, the amount and the type of the stabilizing oxides used, the interaction of the phases of zirconia material during processing are some of the factors which are involved to maintain the metastability of the phase transformation. During aqueous environment, Yttrium hydroxide ($Y[OH]_3H_2O$)is produced when the Y_2O_3 reacts with the water. These will emphasis "Low Temperature Degradation" (LTD). Grain pullout and the presence of grinding or sandblasting results in the transformation of the t to m phases leading to the structural changes in the zirconia, which is usually seen during the aging process. Hence all the frameworks designs such as zirconia implants, abutments should be veneered for this reason. [(54)]

Zirconia based pressable ceramics and core veneer thickness combination affected the luminance transmittance. According to the translucency measurement results the combination of 0.7mm veneer thickness and 0.8mm core thickness exhibited the lowest value of transmittance.

STUDIES OF COLOR STABILITY & DISCOLORATION OF ZIRCONIA

The characteristics of tooth color is optical, to reproduce the similar shade matching to that of adjacent natural tooth is a complex process. Some of the basic principles of color perception for the success of an esthetic restoration are individuals Color perception, the source of light used for color evaluation, the surface and structural characteristics of the tooth and the restorative materials. For the better outcome of an indirect procedure, the clinician should communicate properly to the technician about the color, light source and the surface characteristic of resin and the porcelain material (55)

The absence of metallic collar usually placed on the margin, which is noted by patients as a “black line” as seen with gingival recession is an immediate advantage of PFM restoration because of the natural white color of zirconia. (55) Zirconia differs from traditional alloy by its relative translucency. The important factor responsible for matching color of natural teeth with restorative materials is Translucency. Translucency is the property of a material in which a major portion of the transmitted light undergoes scattering. The translucency of dental porcelain is mainly dependent on the light scattering (56).

If the maximum part of light passing through a ceramic is intensely scattered and diffusely reflected, the material appears to be more opaque. If the minimum part of the light is scattered and most is diffusely transmitted, the material appears to be more translucent. The nature of the chemical substance present in the core, the content of the crystals and the size of the particles are responsible for the light absorption, transmission and reflection. The greater opacity is resulted by the presence of increased crystalline content in order to achieve high strength of core material. [(57)] As soon as the thickness of the core decreases; the translucency of core material increases which ultimately decreases the strength of the material.

Heffernan *et al* [(38)] reported in 2002 an opacity (contrast ratio) of 1.00 (completely opaque) for a 0.5mm thick In-Ceram Zirconia core, and these data have been confirmed by Chen *et al*., but Chen *et al*.[(58)] on his study he found that the opacity value for Cercon Base Zirconia is 1.00 at 0.5mm thickness. Baldissara *et al* reported cercon base zirconia has a highly opaque material. He also did a study with different zirconia material to find the translucency value for which he used Lava Frame of 0.3 and 0.5 mm.

It defines that the zirconia as a “semi-translucent” core material. The core translucency is not always considered to have a positive effect. The presence of discolored tooth remnants, amalgam or other heavily colored restorative materials, metallic post and cores or carbon fiber posts can all interfere with the desired aesthetic result. [59]

In these clinical situations, a highly masking material would be preferable and this reinforces the fact that there is no evidence to support the use of a single ceramic material. [60] Zirconia core translucency is evaluated in the absence of veneering material is not represented for usual clinical conditions, The presence of veneering porcelain can reduce the translucency property which serves as a function of thickness, opacity and of the veneering material itself. The final color of the translucent cores is influenced by the color of the cement [61] and it is possible that this could affect the zirconia core as well. [62]

The color of zirconia does not allow an optimal aesthetic integration to be achieved per se, therefore a veneering material must be used. Liners are used to compensate the negative effect of the zirconia on the final color of the restoration. [63] These liners have been advocated to reduce the zirconia–veneer bond strength and might be a factor (or a co-factor) responsible for one of the reported problems of zirconia framed restorations that is the de-lamination between the zirconia core and the veneering porcelain. Before sintering process, the staining solutions for the zirconia and the use of pre-colored zirconia has been used as alternatives to the use of liners, but their advantages are controversial. Aboushelib *et* *al.* [53]. Stated that the required color for a natural colored zirconia framework is fabricated by placing the ceramic veneers on the labial surface. Whereas for a colored zirconia, to match the natural esthetic a liner material or a deep colored chroma dentin which could simulate the natural esthetic are used. Moreover, Hjerppe *et al.* [64] reported that the color shaded zirconia will be decreased in strength. [65]

Dye Selection: In order to find the proper dye to simulate the stain of the tooth, Rhodamine B, Orange II, Alizarin red (Sigma–Aldrich Co., St. Louis, USA) were selected for this study, because they could meet the following requirements:

1. The chemical formula of the selected dye could simulate the stain of the tooth. Namely, the dye should exhibit similar structures to pigmented carbon-ring compounds or carbon double-bond compounds. [66]
2. The molecular weight of the selected dye was small enough to easily penetrate into the tooth structure. [67]0.15mM, 10ml of Rhodamine B, Orange II, and Alizarin red were prepared, respectively, in test tubes. (Rhodamine B: 554 nm; Orange II: 482 nm; Alizarin red: 675 nm) was measured using a spectrophotometer (U-3010, Hitachi, Tokyo, Japan) at intervals of 10 min.

Staining the natural teeth by immersing it in cool drinks for up to 72 hrs(GROUP-D), Immersing it in Povidone Iodine and evaluated for GROUP –E. Boiled 2gm of tea in 100ml of distilled water for 5min then immersed teeth (GROUP-F) for 72 hrs Stains are up taken and the stain process was monitored at 4, 24, 48, 72 hrs after immersion and the color of the tooth specimens was simultaneously evaluated at the same period of time.

1 gm of Rhodamine dye (GROUP-A) was diluted in 10 ml of distilled water and teeth were immersed in it for 72 hrs stains are up taken and the stain process was monitored at 4, 24, 48, 72 hrs after immersion and the color of the tooth specimens was simultaneously evaluated. Teeth are immersed in Orange II (GROUP-B) and evaluated at the same manner, teeth were immersed in Alizarin red (GROUP-C) and evaluated Rhodamine B and Orange II were diluted with distilled water to a concentration of 0.15mM solution. Alizarin red. Six tooth specimens were divided into six groups with six dyes immersed in 10 ml of Rhodamine B, Orange II, Alizarin Red, Tea solution, Povidone Iodine & Cool drinks respectively.

SUMMARY

To summarize the result of the study on effect of core and veneer thickness of zirconia based pressable ceramics showed

1. The translucency of the restoration is best when there is a minimum thickness of (0.5mm+1.00mm) core and veneer is used.
2. The color masking ability of the zirconia disc is superior for Orange II test solution followed by Alizarin red test solution and Tea test solution.
3. It also shows that the Orange II test solution was better masked if the core & veneer thickness of the zirconia disc is 0.6mm & 0.9mm respectively is used.
4. The Alizarin red test solution was better masked if the core and veneer thickness of the zirconia disc is 0.5mm &1mm and 0.6mm & 0.9mm are used.
5. For Tea test solution the better masking ability was seen when the core & veneer thickness of zirconia disc of 0.5mm &1mm and 0.7mm & 0.8mm respectively are used.

CONCLUSION

The translucency of zirconia ceramics is determined by the specific microstructure of the material. For an overall restoration thickness of 1.5mm, the change in the thickness of zirconia based ceramic veneer is a major factor in determining the translucency of the restoration.

The optical property of zirconia restorations helps clinicians to achieve better esthetic than with metal-ceramic restorations. This optical property of the restoration material is compromised when used for metal post and core, a discolored substrate, or a titanium implant abutment, to avoid this compromised esthetic situation the zirconia coping or a sufficient veneered porcelain can be used.

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