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In vitro procjena i usporedba translucencije dvaju različitih potpuno keramičkih sustava

In Vitro Evaluation and Comparison of the Translucency of Two Different All-Ceramic Systems

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Sažetak

Svrha: Koristeći se u ovom istraživanju *in vitro* mjerenjem, željela se procijeniti i usporediti translucencija dvaju različitih keramičkih sustava s pomoću uređaja za određivanje boje zuba Vita Easyshade. **Materijali i metode:** Procjenjivala se i uspoređivala translucencija litij-disilikatne staklokeramike (IPS e.max Press) i cirkonij-dioksidne keramike (Ceramill ZI). Svih pet uzoraka četvrtastog oblika debljine 0,5 mm proizvedeni su od obje vrste keramike u A1 boji prema ključu boja Vitapan Classical. Uzorci, čija je konačna debljina bila 1,5 mm, naknadno su slojevani i glazirani odgovarajućim obložnim slojem prema preporuci proizvođača. Procjena translucencije obavljena je uređajem VITA Easyshade u dvije faze – prije i poslije slojevanja i glaziranja, na crnoj i bijeloj pozadini. Računala se i vrijednost parametra translucencije. U statističkoj obradi korišteni su jednosmjerni ANOVA i Bonferronijevi testovi ($\alpha = 0,05$). **Rezultati:** Litij-disilikatna staklokeramika bila je u obje faze značajno translucenčnija od cirkonij-oksidge keramike ($P < 0,05$). Translucencija svih uzoraka bila je značajno niža nakon slojevanja i glaziranja obaju keramičkih sustava ($P < 0,05$). **Zaključak:** Na translucenciju dviju različitih dentalnih keramika značajno su utjecali vrsta materijala te faze tijekom pripreme. Unatoč ograničenjima u ovom istraživanju, rezultati mogu biti vrijednosno značajni te pomoći stručnjacima u donošenju estetskih odluka.

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Ključne riječi

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Uvod

Estetski dentalni nadomjestak prema boji, obliku, veličini i površinskoj teksturi treba odgovarati izgledu prirodnoga, zdravog zuba (1, 2).

Tijekom desetljeća standardni metal-keramički nadomjestci zadovoljavali su estetske komponente, no već se neko vrijeme sve češće govori o njihovu nepotpuno zadovoljavajućem estetskom izgledu (3). Najveći nedostaci u estetskom izgledu takvog nadomjestka odnose se na neprozirni keramički sloj kojim se prekriva metalna podloga, a koji uzrokuje neželjeno odbijanje svjetlosti (4).

S druge strane, potpuno keramički sustavi omogućuju veću translucenciju, istovjetnu prirodnom zubu i zato su bolji izbor u postizanju estetskoga uklapanja izgleda prirodnih zuba (5 – 7).

Estetski izrađeni potpuno keramički sustavi trebali bi imati boju i translucenciju sličnu prirodnom zubu (8). Procjenjivanje translucencije dentalnih keramika obavlja se triju metodama: direktnim prijenosom, potpunim prijenosom i spektralnom refleksijom (9). Parametrom translucencije (TP) određuju se razlike reflektiranih boja materijala iste de-

Introduction

An esthetic dental artificial restoration should mimic the vital, intact natural tooth in terms of shade, shape, size, surface texture and color (1,2).

Over the decades the conventional metal ceramic restorations have been considered the standard for providing acceptable esthetics, but some concerns regarding non-optimal esthetics have been reported recently (3). The main complaint for esthetically unpleasant restorations seems to be the opaque porcelain application to mask a metal substructure that causes undesirable light reflection (4).

On the other hand, all-ceramic systems provide a deeper translucency similar to natural tooth and therefore have been advocated as the restoration of choice for matching the natural dentition (5-7).

Esthetically fabricated all-ceramic restorations should have a color and translucency comparable to those of natural teeth (8). There are three methods for evaluating the translucency of dental ceramics: direct transmission, total transmission and spectral reflectance (9). Translucency parameter (TP) defines the difference between reflected colors of a ma-

bljine na crnoj i bijeloj pozadini, te njegova vrijednost odgovara vizualnoj percepciji translucencije ljudskog oka (10).

Različiti potpuno keramički sustavi imaju različite vrijednosti TP-a. Jezgra cirkonij-dioksidne keramike manje je translucentna u usporedbi s ostalim keramičkim sustavima, kao što su staklom infiltrirane keramike koje se odlikuju dobrim estetskim svojstvima (11, 12). Translucencija cirkonij-oksidge keramike ovisi o količini i vrsti aditiva, temperaturi sinteriranja i o atmosferskim uvjetima tijekom procesa sinteriranja i metoda grijanja (13 – 16).

Stoga je svrha ovog istraživanja bila procijeniti i usporediti translucencije dvaju različitih potpuno keramičkih sustava s pomoću uređaja za određivanje boje zuba Vita Easyshade, koristeći se mjerenjem *in vitro*.

Prva hipoteza bila je da će različiti potpuno keramički sustavi imati različitu translucenciju. Druga hipoteza bila je da se translucencija različitih keramičkih uzoraka mijenja tijekom faze izrade.

Materijali i metode

U ovom istraživanju analizirana su dva potpuno keramička sustava (IPS e.max Press, Ivoclar Vivadent, Schaan, Lihtenštajn; Ceramill ZI, Amann Girrbach, Koblach, Austrija). Pet uzoraka četvrtastog oblika (11 mm x 11 mm x 0,5 mm) bilo je izrađeno od obje vrste materijala prema uputama proizvođača u A1 boji prema ključu boja Vitapan Classical (VITA Zahnfabrik, Bad Säckingen, Njemačka).

Razina jezgre

Za izradu jezgre staklokeramičkih uzoraka, četvrtasti voštani uzorci bili su uronjeni u uložni materijal na bazi fosfata (IPS Press Vest Speed, Ivoclar Vivadent, Schaan, Lihtenštajn) i zapečeni u peći (VITA Vacumat 300; VITA Zahnfabrik, Bad Säckingen, Njemačka) na 850 stupnjeva. Korišteni su valjci niske translucencije boje A1. Uzorci su bili prešani (Ivoclar EP600 Combi, Ivoclar Vivadent, Schaan, Lihtenštajn) i ostavljeni na sobnoj temperaturi 30 minuta. Nakon toga uložni je materijal uklonjen i uzorci su polirani uređajem za poliranje (Polix 905, Slifradent, Viterbo, Italija). Debljina uzoraka kontrolirala se digitalnom mjerkom (Pittsburgh, Camarillo, CA, SAD) s preciznošću od 0,1 mm, a završna debljina iznosila je 0,5 mm +/- 0,05 mm.

Za izradu jezgre cirkonij-dioksidnih uzoraka, Ceramill ZI predsinterirani blokovi Y-TZP ZrO₂ (Amann Girrbach, Koblach, Austrija) glodani su CAD/CAM sistemom (Cerec 3, Sirona Dental Systems, Bensheim, Njemačka). Uzorci su bili obojeni s pomoću tekućine Ceramill A1 (Amann Girrbach, Koblach, Austrija), sušeni 45 minuta te sinterirani određeno vrijeme u peći za sinteriranje na određenoj temperaturi prema uputama proizvođača (Elektron, Banja Koviljača, Srbija). Na kraju procesa debljina uzoraka bila je provjerena istom digitalnom mjerkom i postignute su iste dimenzije (11 mm x 11 mm x 0,5 mm).

material with a uniform thickness over a black and a white background and provides a value corresponding directly to human visual perception of translucency (10).

Different all-ceramic systems have different TPs. The zirconia core is less translucent than other dental all-ceramic materials such as glass-infiltrated ceramics, which is known for its good esthetic properties (11,12). Translucency of zirconia is related to the amount and type of additives, the sintering temperature, the atmospheric conditions during the sintering process and the heating methods (13-16).

Therefore, the aim of this study was to evaluate and compare the translucency of two different all-ceramic systems using Vita Easyshade digital shade matching device in an *in vitro* model.

The first hypothesis was that the different all-ceramic systems would have different translucency. The second hypothesis tested was that the stages of fabricating would affect the translucency of different ceramic specimens.

Materials and methods

In this study, 2 different all-ceramic systems were tested (IPS e.max Press, Ivoclar Vivadent, Schaan, Liechtenstein; Ceramill ZI, Amann Girrbach, Koblach, Austria). Five square-shaped (11 mm X 11 mm X 0.5 mm) specimens were fabricated for each material following the manufacturers' instructions in A1 shade according to Vitapan Classical shade tab (VITA Zahnfabrik, Bad Säckingen, Germany).

Core stage

For fabricating glass-ceramic core specimens, square-shaped wax patterns were prepared 11 mm X 11 mm X 1 mm, invested in a phosphate-bonded investment (IPS Press Vest Speed, Ivoclar Vivadent, Schaan, Liechtenstein) and burned out in a furnace (VITA Vacumat 300; VITA Zahnfabrik, Bad Säckingen, Germany) at 850°C. Low translucency (LT) ingots were used to obtain A1 shade. The specimens were heat-pressed (Ivoclar EP600 Combi, Ivoclar Vivadent, Schaan, Liechtenstein) and left at room temperature for 30 minutes. Investment material was removed and specimens polished using a polishing machine (Polix 905, Slifradent, Viterbo, Italy). The thickness of the specimens was controlled with a digital caliper (Pittsburgh, Camarillo, CA, USA) with an accuracy of 0.01 mm and final thickness was set to 0.5 mm ±0.05 mm.

For fabricating zirconia core specimens, Ceramill ZI presintered blocks of Y-TZP ZrO₂ (Amann Girrbach, Koblach, Austria) were milled with CAD/CAM system (Cerec 3, Sirona Dental Systems, Bensheim, Germany). The specimens were colored using Ceramill liquid A1 (Amann Girrbach, Koblach, Austria), left to dry for 45 minutes and subsequently sintered in a sintering furnace according to the manufacturer's heat and time instructions (Elektron, Banja Koviljača, Srbija). At the end of the process the thickness of the specimens was controlled with the same digital caliper and the dimensions of 11 mm X 11 mm X 0.5 mm were obtained.

Mjerenje translucencije

Prije mjerenja svi su uzorci bili očišćeni u destiliranoj vodi 10 minuta i osušeni stlačenim zrakom.

Translucencija je mjerena spektrofotometrom Vita Easyshade (VITA Zahnfabrik, Bad Säckingen, Njemačka). Boja svakog uzorka mjerena je prema sistemu Međunarodne komisije za osvjetljenje (CIE) s tri koordinate: $L^*a^*b^*$. Boja uzorka procjenjivala se na bijeloj ($L^*=99,1$, $a^*=1,8$, $b^*=0,4$), te crnoj (CIE $L^*=0,3$, $a^*=6,4$, $b^*=20,3$) pozadini u kutiji u uvjetima osvjetljenja D 65 (slika 1.). Prije mjerenja spektrofotometar je kalibriran prema uputama proizvođača. Mjerenje je obavljao jedan ispitivač, stručnjak za procjenu boja. Boja uzorka uzastopno je mjerena tri puta te je u obzir uzeta srednja vrijednost mjerenja. Parametar translucencije dobio je mjerenjem boje uzoraka na bijeloj i crnoj pozadini prema formuli:

$$TP = [(L_{\text{white}}^* - L_{\text{black}}^*)^2 + (a_{\text{white}}^* - a_{\text{black}}^*)^2 + (b_{\text{white}}^* - b_{\text{black}}^*)^2]^{1/2}$$

Faza slojevanja i glaziranja jezgre

Nakon primarne procjene translucencije, svi uzorci bili su slojevani i glazirani, uzimajući u obzir kontrakciju keramičkog materijala pri pečenju. Nakon pečenja uzoraka u keramičkoj peći (IPS e.max Ceram, Programat P300, Ivoclar Vivadent, Schaan, Lihtenštajn) debljina uzoraka je kontrolirana, te je na uzorke nanosen tanki sloj tekućine za glaziranje. Nakon toga slijedilo je glaziranje u keramičkoj peći prema uputama proizvođača. Debljina uzoraka bila je ponovno provjerena i iznosila je 1,5 mm +/- 0,05 mm.

Postupak mjerenja translucencije ponovljen je i izračunati su parametri translucencije prema već navedenom protokolu (slika 2.).

Statistička analiza

Razlike između $L^*a^*b^*$ vrijednosti, ovisno o fazi izrade, vrsti keramičkog materijala i boji pozadine, analizirane su nezavisnim t-testom. Vrijednosti parametra translucencije u različitim keramičkim sistemima analizirane su ANOVA i Bonferonijevim testom. Statistička analiza obavljena je u programu SPSS 19.0; (SPSS, Čikago, IL, SAD).

Rezultati

Usporedba $L^*a^*b^*$ vrijednosti jezgri te slojevanih i glaziranih uzoraka dvaju potpuno keramičkih sustava na bijeloj i crnoj pozadini prikazana je na slikama 3. i 4.

Na bijeloj pozadini srednje L^* i b^* vrijednosti staklokeramičke jezgre (e.max) bile su značajno više, a a^* vrijednosti bile su značajno niže od $L^*a^*b^*$ vrijednosti staklokeramičkih slojevanih i glaziranih uzoraka (slika 3., tablica 1.). Srednje L^* vrijednosti uzoraka cirkonij-dioksidne jezgre (ZrO_2) bile su značajno niže, dok su a^* i b^* vrijednosti bile značajno više u usporedbi s cirkonij-dioksidnim slojevanim i glaziranim uzorcima na istoj pozadini (slika 3., tablica 1.).

Translucency measurement

Before the measurement, all the specimens were ultrasonically cleaned in distilled water for 10 minutes and dried with compressed air.

Translucency was measured using spectrophotometer Vita Easyshade (VITA Zahnfabrik, Bad Säckingen, Germany). The color of each specimen was measured according to Commission Internationale de l'Eclairage (CIE) system based on three coordinates – $L^*a^*b^*$. The color of the specimen was measured over a white (CIE $L^*=99.1$, $a^*=1.8$, $b^*=0.4$) and a black (CIE $L^*=0.3$, $a^*=6.4$, $b^*=-20.3$) background in a viewing booth under D65 standard illumination (Figure 1). Before the measurement, the spectrophotometer was calibrated according to the manufacturer's instructions. The measurement was performed by one examiner, well trained in color assessment. The color of the specimen was measured consecutively three times, and the average of the three readings was calculated to give the initial color of the specimen.

The TP was obtained by calculating the color difference between the specimen over the white background and that over the black background as follows (10):

$$TP = [(L_{\text{white}}^* - L_{\text{black}}^*)^2 + (a_{\text{white}}^* - a_{\text{black}}^*)^2 + (b_{\text{white}}^* - b_{\text{black}}^*)^2]^{1/2}$$

Veneered and glazed core stage

After the initial translucency evaluation all the specimens were veneered and glazed with layering technique considering the firing shrinkage of the ceramics. After firing the specimens in a ceramic furnace (IPS e.max Ceram, Programat P300, Ivoclar Vivadent, Schaan, Liechtenstein) the thickness of the specimens was controlled and a thin layer of glazing liquid was applied and glazed in the ceramic furnace following the manufacturers' instructions. The thickness of the specimens was controlled again and set to 1.5 mm ± 0.05 mm.

Translucency measurement was repeated and TP calculated as previously described (Figure 2).

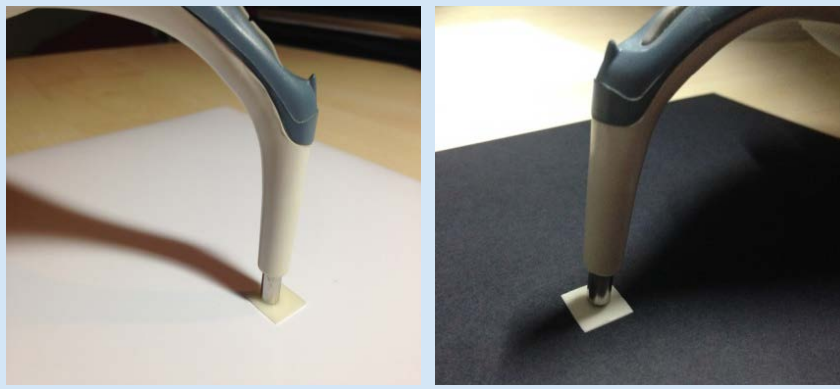
Statistical analysis

The difference between $L^*a^*b^*$ values dependent on the core stage, type of ceramic material and color of the background was analyzed using independent t-test. TP values in different ceramic systems were analyzed using one-way ANOVA and Bonferoni corrections. The statistical analysis was performed using SPSS statistical program 19.0; (SPSS, Chicago, IL, USA).

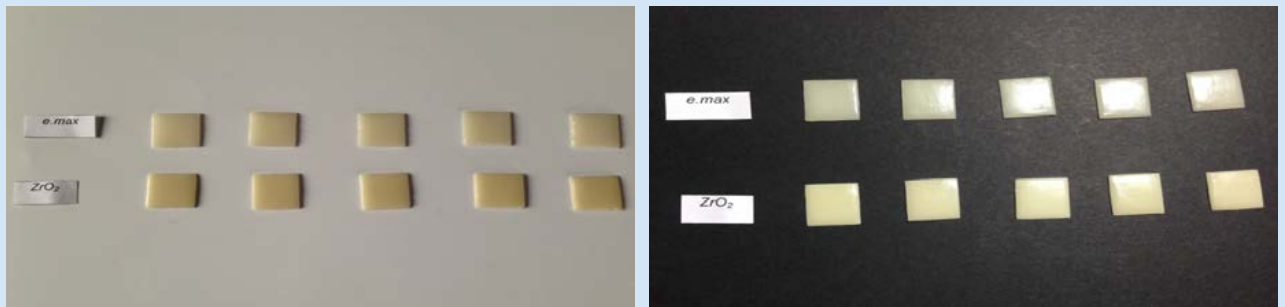
Results

Comparison of $L^*a^*b^*$ values of core and veneered and glazed specimens for two ceramic systems measured on white and black backgrounds are shown in Figures 3 and 4.

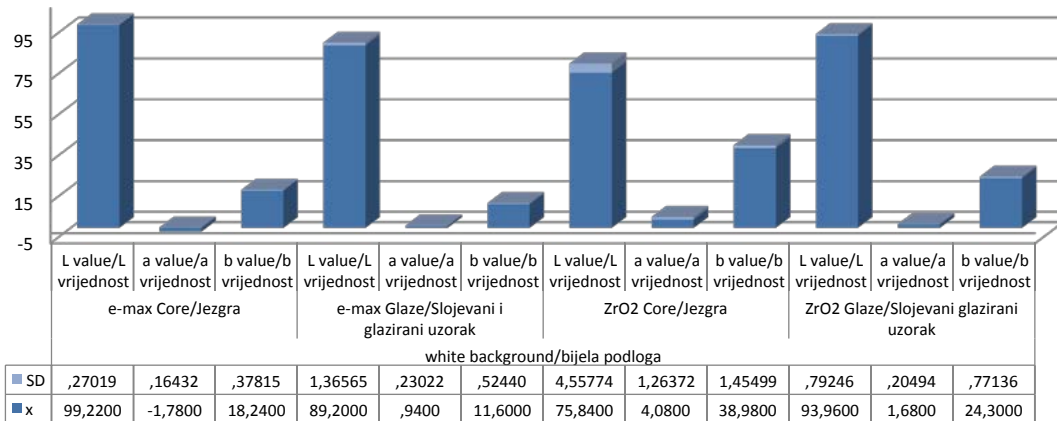
On the white background the mean L^* and b^* values for glass-ceramic core (e.max) were significantly higher and a^* values significantly lower than $L^*a^*b^*$ values for glass-ceramic veneered and glazed specimens (Figure 3, Table 1). The mean L^* values for zirconia core (ZrO_2) were significantly lower and a^* and b^* values significantly higher than for zirconia veneered and glazed specimens on the same background (Figure 3, Table 1).



Slika 1. Procjena L*a*b* vrijednosti uzoraka na bijeloj i crnoj pozadini.
Figure 1 L*a*b* measurements of specimens over white and black backgrounds.



Slika 2. Slojevani i glazirani staklokeramički i cirkonij-dioksidni uzorci boje A1 na bijeloj i crnoj pozadini.
Figure 2 A1 veneered and glazed specimens of glass-ceramic and zirconia all-ceramic systems on white and black background.



Slika 3. Lab vrijednosti jezgre, slojevanih i glaziranih staklokeramičkih i cirkonij-dioksidnih uzoraka na bijeloj pozadini
Figure 3 Lab values of core, veneered and glazed glass-ceramic and zirconia specimens on the white background

Tablica 1. Statistički značajne razlike Lab vrijednosti staklokeramičkih i cirkonij-dioksidnih uzoraka ovisno o fazi izrade
Table 1 Statistically significant difference in Lab values of glass-ceramic and zirconia specimens depending on the stage of their fabrication

			t value/t vrijednost	degree of freedom/ stupanj slobode	p value/p vrijednost
white background/bijela podloga	e-max	L value/L vrijednost	8,987	8	,001
		a value/a vrijednost	-21,503	8	,000
		b value/b vrijednost	22,965	8	,000
	ZrO ₂	L value/L vrijednost	-8,758	8	,000
		a value/a vrijednost	4,192	8	,003
		b value/b vrijednost	19,933	8	,000
black background/crna podloga	e-max	L value/L vrijednost	-1,376	8	,206
		a value/a vrijednost	-5,921	8	,000
		b value/b vrijednost	27,621	8	,000
	ZrO ₂	L value/L vrijednost	-15,975	8	,000
		a value/a vrijednost	5,554	8	,001
		b value/b vrijednost	12,355	8	,000

Na crnoj pozadini srednje L* vrijednosti staklokeramičke jezgre bile su malo niže, ali ne značajno od istih vrijednosti slojevanih i glaziranih uzoraka, a pritom su a* i b* vrijednosti ostale iste (slika 4., tablica 1.). Kod cirkonij-dioksidne keramike, srednje L* vrijednosti bile su značajno više kod slojevanih i glaziranih uzoraka, a a* i b* vrijednosti značajno niže (slika 4., tablica 1.).

Na obje pozadine srednje L* vrijednosti uzoraka cirkonij-dioksidne jezgre i slojevanih i glaziranih uzoraka bile su značajno niže od staklokeramičkih, s iznimkom L* vrijednosti za cirkonij-dioksidne slojevane i glazirane uzorke na crnoj pozadini kod kojih su L* vrijednosti bile više (slika 3. i 4., tablica 2.). Srednje a* i b* vrijednosti na obje pozadine bile su značajno više za oba cirkonij-dioksidna uzorka (slika 3. i 4., tablica 2.).

Srednje L* a* b* vrijednosti za sve ispitane uzorke su bile značajno niže na crnoj pozadini (slika 3. i 4., tablica 3.).

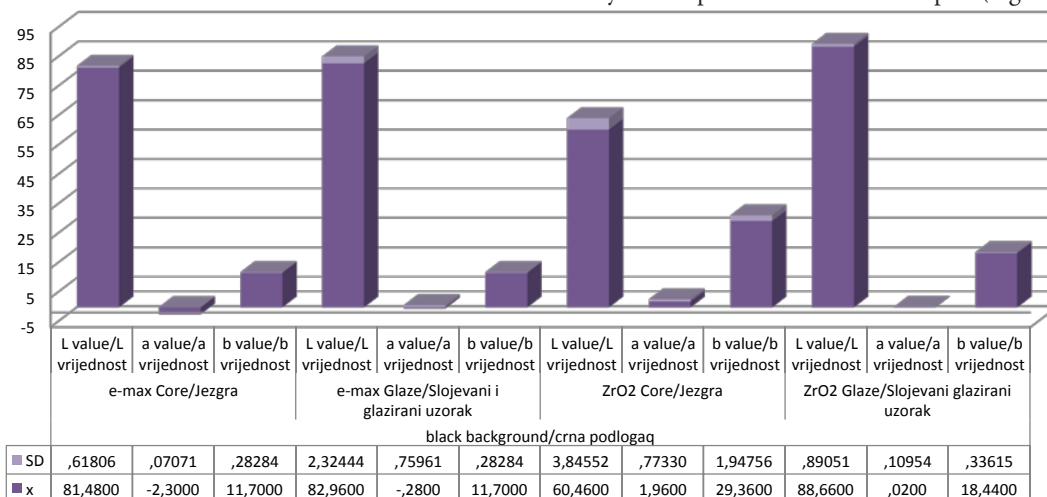
Translucencija cirkonij-dioksidnih jezgara te slojevanih i glaziranih uzoraka bila je manja od staklokeramičke (F = 75,682; df = 3; p = 0,000; slika 5., tablica 4.). Svi slojevani i glazirani uzorci imali su manje vrijednosti translucencije u usporedbi s uzorcima jezgara (slika 5., tablica 4.).

On the black background the mean L* values for glass-ceramic core were slightly, but not significantly lower than the same values for veneered and glazed specimens, while a* and b* values had the same values (Figure 4, Table 1). For the zirconia ceramics, the mean L* values were significantly higher for the veneered and glazed specimens, and a* and b* values were significantly lower (Figure 4, Table 1).

On both backgrounds the mean L* values for both zirconia core and veneered and glazed specimens were significantly lower than for glass-ceramic ones, with the exception of L* values for zirconia veneered and glazed specimens on the black background where the mean L* values were higher (Figures 3 and 4, Table 2). The mean a* and b* values on both backgrounds were significantly higher for both zirconia specimens (Figures 3 and 4, Table 2).

The mean L*a*b* values for all the measured specimens were significantly lower on the black background (Figures 3 and 4, Table 3).

The translucencies of zirconia core specimens as well as veneered and glazed ones were lower than the glass-ceramic ones (F=75.682; df=3; p=0.000; Figure 5, Table 4). All the veneered and glazed specimens had lower values of translucency in comparison with their core pair (Figure 5, Table 4).



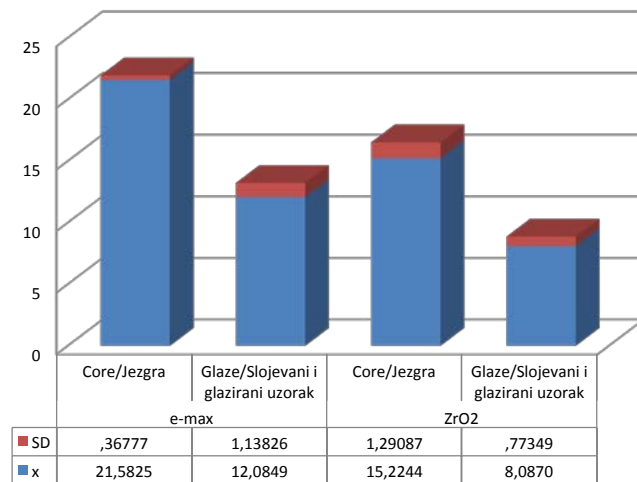
Slika 4. Lab vrijednosti jezgre, slojevanih i glaziranih staklokeramičkih i cirkonij-dioksidnih uzoraka na crnoj pozadini
Figure 4 Lab values of core, veneered and glazed glass-ceramic and zirconia specimens on the black background

Tablica 2. Statistički značajne razlike Lab vrijednosti različitih uzoraka ovisno o vrsti keramičkog sustava
Table 2 Statistically significant difference in Lab values of different specimens depending on the type of ceramic system

		t value/t vrijednost	degree of freedom/ stupanj slobode	p value/p vrijednost
white background/ bijela podloga	Core/Jezgra	L value/L vrijednost	12,831	8 ,000
		a value/a vrijednost	-10,282	8 ,000
		b value/b vrijednost	-30,849	8 ,000
	Glaze/Slojevani i glazirani uzorak	L value/L vrijednost	6,756	8 ,017
		a value/a vrijednost	-5,369	8 ,001
		b value/b vrijednost	-30,446	8 ,000
black background/crna podloga	Core/Jezgra	L value/L vrijednost	12,068	8 ,000
		a value/a vrijednost	-12,267	8 ,000
		b value/b vrijednost	-20,066	8 ,000
	Glaze/Slojevani i glazirani uzorak	L value/L vrijednost	-5,120	8 ,001
		a value/a vrijednost	-5,874	8 ,048
		b value/b vrijednost	-56,415	8 ,000

Tablica 3. Statistički značajna razlika Lab vrijednosti različitih uzoraka na bijeloj i crnoj pozadini
Table 3 Statistically significant difference in Lab values between different specimens dependent on white and black background

			t value/t vrijednost	degree of freedom/ stupanj slobode	p value/p vrijednost
e-max	Core/Jezgra	L value/L vrijednost	68,156	8	,000
		a value/a vrijednost	6,500	8	,000
		b value/b vrijednost	30,968	8	,000
	Glaze/Slojevani i glazirani uzorak	L value/L vrijednost	10,152	8	,000
		a value/a vrijednost	3,437	8	,009
		b value/b vrijednost	19,468	8	,000
ZrO ₂	Core/Jezgra	L value/L vrijednost	5,767	8	,000
		a value/a vrijednost	3,200	8	,013
		b value/b vrijednost	8,848	8	,000
	Glaze/Slojevani i glazirani uzorak	L value/L vrijednost	9,942	8	,000
		a value/a vrijednost	15,973	8	,000
		b value/b vrijednost	15,573	8	,000



Slika 5. Vrijednosti parametra translucencije jezgre te slojevanih i glaziranih staklokeramičkih i cirkonij dioksidnih uzoraka
Figure 5 TP value of core, veneered and glazed glass-ceramic and zirconia specimens

Tablica 4. Statistički značajna razlika parametra translucencije ovisno o vrsti uzorka
Table 4 Statistically significant difference in TP values depending on the type of specimen

		Mean Difference/ Srednja razlika	p value/p vrijednost
E-max Core/Jezgra	E-max Glaze/Slojevani i glazirani uzorak	9,49	,000
	ZrO ₂ Core/Jezgra	6,35	,000
	ZrO ₂ Glaze/Slojevani i glazirani uzorak	13,49	,000
E-max Glaze/Slojevani i glazirani uzorak	E-max Core/Jezgra	-9,49	,000
	ZrO ₂ Core/Jezgra	-3,13	,001
	ZrO ₂ Glaze/Slojevani i glazirani uzorak	3,99	,001
ZrO ₂ Core/Jezgra	E-max Core/Jezgra	-6,35	,000
	E-max Glaze/Slojevani i glazirani uzorak	3,13	,001
	ZrO ₂ Glaze/Slojevani i glazirani uzorak	7,13	,000
ZrO ₂ Glaze/Slojevani i glazirani uzorak	E-max Core/Jezgra	-13,49	,000
	E-max Glaze/Slojevani i glazirani uzorak	-3,99	,001
	ZrO ₂ Core/Jezgra	-7,13	,000

Rasprava

U ovom istraživanju digitalno mjerene CIE L*a*b* vrijednosti na bijeloj i crnoj pozadini poslužile su za matematičko izračunavanje parametra translucencije (10). Ovo istraživanje pokazalo je da staklokeramički uzorci, (jezgre i slojevani te glazirani uzorci) u različitim fazama pripreme pokazuju veću translucenciju u usporedbi s cirkonij-dioksidnim uzorcima. Stoga su naše obje hipoteze prihvaćene – prva prema kojoj bi različiti potpuno keramički sustavi trebali imati različite translucencije, te druga da faze tijekom izrade mogu utjecati na translucenciju različitih keramičkih uzoraka.

Naši rezultati u skladu su s dosadašnjim istraživanjima. Wang i suradnici objavili su rezultate vrijednosti parametra translucencije staklokeramike koji su iznosili od 2,2 do 25,3, te cirkonij-dioksidne keramike od 5,5 do 15,1 (17). U našem istraživanju parametar translucencije za slojevane i glazirane staklokeramičke uzorke bio je od 12 +/- 1,1, a za slojevane i glazirane cirkonij-dioksidne uzorke od 8 +/- 7. Kako ističu Baldissara i suradnici te i Kurtlmus-Yilmaz i njegovi kolege, pronađen je značajno veći stupanj translucencije kod litij-disilikatne staklokeramike u usporedbi s cirkonij-dioksidnom keramikom (18, 21). Ovaj nalaz može se pripisati kristalnom svojstvu cirkonij-dioksidne keramike, što pridonosi boljoj čvrstoći materijala, ali istodobno nehomogenost kristala uzrokuje različite indekse loma i lošu translucenciju (22, 23). Da bi se poboljšala optička svojstva cirkonij-dioksidnih nadomjestaka, primjenjuju se različiti postupci slojevanja jezgre (24 – 26).

Druga hipoteza našeg istraživanja o utjecaju faze izrade keramičkog uzorka na translucenciju pokazala se točnom. Rezultati ovog istraživanja pokazali su da se translucencija slojevanih i glaziranih keramičkih uzoraka značajno smanjila, te da se parametar translucencije obaju keramičkih sustava promijenio nakon procesa slojevanja (slika 5., tablica 3.). Rezultati Heffernana i suradnika također su pokazali značajno smanjenje translucencije nakon slojevanja (11, 12). Objasnili su to činjenicom da struktura i veličina obložne keramike, povećana debljina uzorka i promjene tijekom dodatnog procesa zagrijavanja jezgre uzoraka, utječu na promjenu translucencije (11, 12).

Translucencija dentalne keramike mijenja se ovisno o svojstvima materijala, manipulativnim varijablama i okruženju (3). Stevenson i Ibbetson dokazali su da boja zuba, debljina keramičkih slojeva i neprozirnost materijala utječu na boju keramičkoga nadomjestka (27). Heffernan i suradnici ustanovili su, pak, da litij-disilikatne jezgre trebaju imati minimalnu debljinu 0,8 mm, a staklom infiltrirane te itrijem stabilizirane cirkonij-dioksidne jezgre 0,5 mm, prema preporukama proizvođača (11, 12).

U ovom istraživanju i prema preporuci Heffernana, debljine početnih uzoraka bile su određene na 0,5 mm, a debljine uzoraka tijekom procesa slojevanja i glaziranja dosegnule su 1,5 mm. Mi se nismo koristili jezgrama različitih debljina jer, kao što je i navedeno, debljina materijala utječe na promjenu translucencije (4, 28 – 30).

Površinski zahvati kao što su pjeskarenje, jetkanje, laserska obrada ili sinteriranje također mogu utjecati na translucenciju keramičkog materijala (30 – 32).

Discussion

Digitally measured CIE L*a*b* values on the white and black background in this study served for the mathematical calculation of TP (10). In this study, glass-ceramic specimens in different stages of fabrication (core, veneered and glazed) showed higher translucency compared to the zirconia ones and therefore both our hypotheses that the different all-ceramic systems would have different translucency and that the stages of fabricating would affect the translucency of different ceramic specimens were accepted.

Our results are in agreement with some previous studies. Wang et al. reported TP values of the glass-ceramics that ranged from 2.2 to 25.3 and the zirconia ceramics from 5.5 to 15.1 (17). In our study, TP for glass-ceramic veneered and glazed specimens was 12 ± 1.1 and for zirconia veneered and glazed specimens 8 ± 0.7 . Significantly higher rate of translucency in lithium disilicate glass ceramic in comparison to the zirconia ceramics was also found in Baldissara et al., Kurtlmus-Yilmaz et al. and many others (18-21). This finding can be attributed to the crystalline content of zirconia in order to achieve a greater strength results, but at the same time the inhomogeneity of crystals causes different refractive indices and therefore poor translucency (22, 23). In order to improve the optical behavior of the zirconia restorations, shaded zirconia cores were developed (24-26).

The second hypothesis in our study was that the stages of fabricating would affect the translucency of different ceramic specimens and it was supported by the results. The data obtained from this study showed that the translucency of veneered and glazed ceramics significantly decreased and the translucency parameters of both ceramic systems changed after veneering (Figure 5, Table 3). The results of Heffernan et al. also showed significant decrease of translucency after veneering process (11,12). They have explained it by the fact that the structure and size of veneer ceramic, increased specimen thickness, reflectance and the interface between the core and veneer ceramic and the changes that occurred in core material after additional firing might cause the translucency difference (11,12).

The esthetics, together with the translucency of the dental ceramic materials, changes depending on the properties of the material, manipulative variables and the environment (3). Stevenson and Ibbetson reported that the shades of all-ceramic restorations were also influenced by tooth color, thickness of the ceramic layers and material opacity (27). Heffernan et al. suggested that lithium disilicate cores should be fabricated at a minimum thickness of 0.8 mm and glass infiltrated and yttrium stabilized zirconia cores at 0.5 mm according to the manufacturer's recommendations (11,12).

In the present study, the specimen core thicknesses were determined to be 0.5 mm and the veneered and glazed thicknesses were 1.5 mm which is in accordance with Heffernan's suggestion. We did not use cores with different thicknesses because it was previously reported that the material thickness changes the translucency (4, 28-30).

The surface treatments such as sandblasting, etching, irradiating with the laser or sintering conditions can also affect the translucency of the ceramic material (30-32).

U ovom istraživanju naša su ograničenja bila korištenje samo jednoga mjernog instrumenta (1. model uređaja VITA Easyshade), izabrali smo dva potpuno različita keramička sustava u strukturi i proizvodnji koji se najčešće upotrebljavaju u našoj svakodnevnoj praksi, te procijenili samo A1 boju keramičkog materijala. Zato u našem budućem istraživanju trebamo povećati broj uzoraka, keramičkih sustava, boja i mjernih uređaja.

Zaključak

Značajan utjecaj na translucenciju dvaju različitih dentalnih keramičkih sustava imale su faze tijekom njihove izrade i vrste materijala. Staklokeramički materijal pokazao je veću translucenciju, ali se u oba sustava translucencija smanjivala poslije procesa slojevanja i glaziranja. Unatoč ograničenjima, rezultati dobiveni u ovom istraživanju mogu pomoći stručnjacima u donošenju odluka vezanih za estetsku.

Sukob interesa

Nije ga bilo.

As a limitation of the study, we used only one measuring device (the first prototype of VITA Easyshade), chose only two all-ceramic systems different in structure and fabrication used in our everyday clinical practice and evaluated only shade A1. Therefore, in our further investigation we have to increase the number of specimens, all-ceramic systems, shades and measuring devices.

Conclusions

The translucency of two different dental ceramics was significantly influenced by both material and stages of preparation. Glass-ceramic system revealed higher translucency and in both systems the translucency decreased after veneering and glazing. Within the limitations of the experiment, these results can be valuable and help the clinician to make appropriate esthetic decisions.

Conflict of interest

None declared

Abstract

Objectives: The aim of this study was to evaluate and compare the translucency of two different all-ceramic systems using Vita Easyshade digital shade matching device in an *in vitro* model. **Materials and methods:** Translucency of lithium disilicate glass-ceramic (IPS e.max Press) and zirconia all-ceramic system (Ceramill ZI) were evaluated and compared. A total of 5 square-shaped specimens with 0.5 mm thickness were fabricated from each ceramic system in A1 shade according to Vitapan Classical shade tab. Specimens were then veneered and glazed with corresponding veneer ceramics recommended by each system manufacturer and the total thickness was set to 1.5 mm. Translucency was evaluated using VITA Easyshade in two stages: before and after veneering and glazing on black and white background. Translucency parameter (TP) was calculated. A one-way ANOVA and Bonferonni tests were used when appropriate ($\alpha=0.05$). **Results:** Lithium disilicate glass-ceramic was significantly more translucent than the zirconia system in both stages ($P<0.05$). Translucency of all specimens was significantly decreased after veneering and glazing in both all-ceramic systems ($P<0.05$). **Conclusion:** The translucency of two different dental ceramics was significantly influenced by both material and stages of preparation. Within the limitations of the experiment, these results can be valuable and help the clinician to make appropriate esthetic decisions.

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Key words

Tooth Discoloration; Dental Veneers;
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References

- Vichi A, Luca C, Corciolani G, Ferrari M. Color related to ceramic and zirconia restorations: A review. *Dent Mater.* 2011 Jan;27(1):97-108.
- Chaiyabutr Y, Kois JC, Lebeau D, Nunokawa G. Effect of abutment tooth color, cement color, and ceramic thickness on the resulting optical color of a CAD/CAM glass-ceramic lithium disilicate-reinforced crown. *J Prosthet Dent.* 2011 Feb;105(2):83-90.
- Lee YK, Cha HS, Ahn JS. Layered color of all-ceramic core and veneer ceramics. *J Prosthet Dent.* 2007 May;97(5):279-86.
- Son HJ, Kim WC, Jun SH, Kim YS, Ju SW, Ahn JS. Influence of dentin porcelain thickness on layered all-ceramic restoration color. *J Dent.* 2010;38 Suppl 2:e71-7.
- O'Brien WJ. Double layer effect and other optical phenomena related to esthetics. *Dent Clin North Am.* 1985 Oct;29(4):667-72.
- Raptis NV, Michalakos KX, Hirayama H. Optical behavior of current ceramic systems. *Int J Periodontics Restorative Dent.* 2006 Feb;26(1):31-41.
- Kelly JR, Nishimura I, Campbell SD. Ceramics in dentistry: historical roots and current perspectives. *J Prosthet Dent.* 1996 Jan;75(1):18-32.
- Yu B, Ahn JS, Lee YK. Measurement of translucency of tooth enamel and dentin. *Acta Odontol Scand.* 2009;67(1):57-64.
- Spink LS, Rungtuanant P, Megremis S, Kelly JR. Comparison of an absolute and surrogate measure of relative translucency in dental ceramics. *Dent Mater.* 2013 Jun;29(6):702-7.
- Johnston WM, Ma T, Kienle BH. Translucency parameter of colorants for maxillofacial prostheses. *Int J Prosthodont.* 1995 Jan-Feb;8(1):79-86.
- Heffernan MJ, Aquilino SA, Diaz-Arnold AM, Haselton DR, Stanford CM, Vargas MA. Relative translucency of six all-ceramic systems. Part II: core and veneer materials. *J Prosthet Dent.* 2002 Jul;88(1):10-5.
- Heffernan MJ, Aquilino SA, Diaz-Arnold AM, Haselton DR, Stanford CM, Vargas MA. Relative translucency of six all-ceramic systems. Part I: core materials. *J Prosthet Dent.* 2002 Jul;88(1):4-9.
- Casolco SR, Xu J, Garay JE. Pransparent/translucent polycrystalline nanostructures yttria stabilized zirconia with varying colors. *Scr Mater.* 2008;58:516-9.
- Jiang L, Liao Y, Wan Q, Li W. Effects of sintering temperature and particle size on the translucency of zirconium dioxide dental ceramic. *J Mater Sci Mater Med.* 2011 Nov;22(11):2429-35.
- Anselmi-Tamburini U, Woolman JN, Munir ZA. Transparent nanometric cubic and tetragonal zirconia obtained by high-pressure pulsed electric current sintering. *Adv Funct Mater.* 2007;17:3267-73.
- Yang D, Raj R, Conrade H. Enhanced sintering rate of Zirconia (3Y-TZP) through the effect of a weak dc electric field on grain growth. *J Am Ceram Soc.* 2010;93:2935-7.
- Wang F, Takahashi H, Iwasaki N. Translucency of dental ceramics with different thicknesses. *J Prosthet Dent.* 2013 Jul;110(1):14-20.

18. Baldissara P, Llukacej A, Ciocca L, Valandro FL, Scotti R. Translucency of zirconia copings made with different CAD/CAM systems. *J Prosthet Dent.* 2010 Jul;104(1):6-12.
19. Spyropoulou PE, Giroux EC, Razzoog ME, Duff RE. Translucency of shaded zirconia core material. *J Prosthet Dent.* 2011 May;105(5):304-7.
20. Pecho OE, Ghinea R, Ionescu AM, Cardona Jde L, Paravina RD, Pérez Mdel M. Color and translucency of zirconia ceramics, human dentine and bovine dentine. *J Dent.* 2012 Dec;40 Suppl 2:e34-40.
21. Kurtulmus-Yilmaz S, Ulusoy M. Comparison of the translucency of shaded zirconia all-ceramic systems. *J Adv Prosthodont.* 2014 Oct;6(5):415-22.
22. Kelly JR, Nishimura I, Campbell SD. Ceramics in dentistry: historical roots and current perspectives. *J Prosthet Dent.* 1996 Jan;75(1):18-32.
23. Holloway JA, Miller RB. The effect of core translucency on the aesthetics of all-ceramic restorations. *Pract Periodontics Aesthet Dent.* 1997 Jun-Jul;9(5):567-74; quiz 576.
24. Manicone PF, Rossi Iommetti P, Raffaelli L. An overview of zirconia ceramics: basic properties and clinical applications. *J Dent.* 2007 Nov;35(11):819-26.
25. Manicone PF, Rossi Iommetti P, Raffaelli L, Paolantonio M, Rossi G, Berardi D, Perfetti G. Biological considerations on the use of zirconia for dental devices. *Int J Immunopathol Pharmacol.* 2007 Jan-Mar;20(1 Suppl 1):9-12.
26. Hjerpe J, Närhi T, Fröberg K, Vallittu PK, Lassila LV. Effect of shading the zirconia framework on biaxial strength and surface microhardness. *Acta Odontol Scand.* 2008 Oct;66(5):262-7.
27. Stevenson B, Ibbetson R. The effect of the substructure on the colour of samples/restorations veneered with ceramic: a literature review. *J Dent.* 2010 May;38(5):361-8.
28. Dozić A, Kleverlaan CJ, Meegdes M, van der Zel J, Feilzer AJ. The influence of porcelain layer thickness on the final shade of ceramic restorations. *J Prosthet Dent.* 2003 Dec;90(6):563-70.
29. Dikicier S, Ayyildiz S, Ozen J, Sipahi C. Effect of varying core thicknesses and artificial aging on the color difference of different all-ceramic materials. *Acta Odontol Scand.* 2014 Nov;72(8):623-9.
30. Turgut S, Bagis B, Ayaz EA, Korkmaz FM, Ulusoy KU, Bagis YH. How will surface treatments affect the translucency of porcelain laminate veneers? *J Adv Prosthodont.* 2014 Feb;6(1):8-13.
31. Turgut S, Bağış B, Korkmaz FM, Tamam E. Do surface treatments affect the optical properties of ceramic veneers? *J Prosthet Dent.* 2014 Sep;112(3):618-24.
32. Kim MJ, Ahn JS, Kim JH, Kim HY, Kim WC. Effects of the sintering conditions of dental zirconia ceramics on the grain size and translucency. *J Adv Prosthodont.* 2013 May;5(2):161-6.