Primljen/ Recived on: 05.05.2019
Revidiran / Revised on: 09.06.2019
Prihvaćen/ Accepted on :15.07.2019

ORIGINALNI RAD
ORIGINAL ARTICLE
doi: 10.5937/asn1980956K

KOMPARACIJA POVRŠINSKE HRAPAVOSTI STOMATOLOŠKIH MATERIJALA KAO FAKTORA ADHEZIJE ORALNOG BIOFILMA

COMPARISON OF SURFACE ROUGHNESS OF DENTAL MATERIALS AS AN ADHESION FACTOR OF ORAL BIOFILM

Milena Kostić[1,2], Jana Pešić Stanković[3], Dušan Petković[4], Marko Igić [1,2], Marija Bradić Vasić[5], Nikola Glogorijević[1]

[1] UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, PREDMET STOMATOLOŠKA PROTETIKA, NIŠ, SRBIJA
[2] UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, KLINIKA ZA STOMATOLOGIJU NIŠ, ODELJENJE ZA PROTETIKU, SRBIJA
[3] UNIVERZITET U NIŠU, MEDICINSKI FAKULTET, INSTITUT ZA JAVNO ZDRAVLJE, NIŠ, SRBIJA
[4] UNIVERZITET U NIŠU, MAŠINSKI FAKULTET, KATEDRA ZA PROIZVODNO INFORMACIONE TEHNOLOGIJE, NIŠ,SRBIJA
[5] UNIVERZITET U NIŠU, MEDICINSKI FAKULTET NIŠ, STUDENT NA DOKTORSKIM STUDIJAMA

[1]UNIVERSITY OF NIS, FACULTY OF MEDICINE, DEPARTEMENT OF PROSTODONTICS, NIS , SERBIA
[2]UNIVERSITY OF NIS, FACULTY OF MEDICINE, CLINIC OF DENTISTRY, DEPARTMENT OF PROSTODONTICS, NIŠ, SERBIA
[3]UNIVERSITY OF NIS, FACULTY OF MEDICINE, PUBLIC HEALTH INSTITUTE, NIS, SERBIA
[4]UNIVERSITY OF NIŠ,
FACULTY OF MECHANICAL ENINEERING, DEPARTEMENT OF PRODUCTION INFORMATION TECHNOLOGIES, NIS, SERBIA
[5]UNIVERSITY OF NIS, FACULTY OF MEDICINE, PHD STUDENT, NIS, SERBIA

Sažetak

Uvod: *Da bi se materijal smatrao biološki prihvatljivim neophodno je da poseduje takav površinski dizajn da što manje reaguje sa tkivom i agensima iz okoline.Nijedna metoda obrade ne može da proizvede molekularno ravnu površinu stomatoloških materijala.*
Cilj: *istraživanja bio je ispitati hrapavost različitih stomatoloških materijala, pomoću mehaničkog profilometra.*
Materijal i metode: *Ispitivani materijal obuhvatio je kompozit, toplo polimerizovani akrilat, hladno polimerizovane akrilate koji se koriste u protetici i ortodonciji, cirkonijum oksidnu keramiku i staklokermiku. Uzorci materijala za istraživanje su napravljeni prema uputstvu proizvođača. Merenje hrapavosti dobijenih uzoraka izvršeno je pomoću Mitutoyo SJ-301 Suftest uređaja, prevlačenjem čitača preko uzoraka, u dva pravca (vertikalno i horizontalno), čime su dobijena dve vrednosti merenja za svaki materijal pojedinačno.*
Rezultati: *Merenjem hrapavosti materijala, utvrđeno je da među ispitivanim uzorcima postoje značajne razlike. Najveća hrapavost izmerena je kod hladno polimerizovanog akrilata koji se koristi u protetici, dok je najmanja hrapavost izmerenakod kompozitnog materijala.*
Zaključak: *Hrapavost je bila značajno veća kod hladno polimerizovanih akrilata u odnosu na ostale ispitivane materijale, te ga, kada je god to moguće, treba zameniti toplo polimerizvanim akrilatom.U cilju smanjenja hrapavosti stomatoloških materijala treba poštovati principe njihove pripreme i posebno površinske obrade (postupak poliranja i glaziranja).*

Ključne reči: *hrapavost; stomatološki materijali*

Corresponding author:
Assistant Prof Milena Kostić, DDS, MSD, PhD
University of Niš, Faculty of Medicine, Clinic of Dentistry
Blvd. dr Z. Djindjića 52, 18000 Niš, Serbia
Tel. +38184226216;
E-mail:milena.kostic@medfak.ni.ac.rs

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Abstract

Introduction: *In order for a material to be considered biologically acceptable, it is necessary to have such a surface design that it reacts as little as possible with tissue and environmental agents. No processing method can produce a molecularly flat surface of dental materials.*
The aim: *of the study was to examine the roughness of various dental materials, using a mechanical profilometer.*
Material and methods: *The test included different materials such as composite, hot polymerized acrylate, cold polymerized acrylates used in prosthetics and orthodontics, zirconium oxide ceramics and glass-ceramics. Samples of the research materials were made according to the manufacturer's instructions. The measurement of the roughness of the obtained samples was performed using a Mitutoyo SJ-301 Suftest device, dragging the reader across the samples, in two directions (vertical and horizontal), thus obtaining two measurement values for each material individually.*
Results: *By measuring the roughness of the material, it was found that there were significant differences between the samples tested. The highest roughness was measured for cold polymerized acrylates used in prosthetics, while the lowest roughness was measured for composite materials.*
Conclusion: *The roughness was significantly higher for cold polymerized acrylates than the other tested materials and should, wherever possible, be replaced by hot polymerized acrylates. In order to reduce the roughness of dental materials, the principles of their preparation and in particular the surface treatment (polishing and glazing process) should be followed.*

Keywords: *roughness; dental materials*

Uvod

Da bi se materijal smatrao biokompatibilnim neophodno je da, između ostalog, poseduje takav površinski dizajn da što manje reaguje sa tkivom i agensima iz okoline[1]. Neravna površina akrilata, keramike i kompozitnih materijala predstavlja predilekciono mesto za akumulaciju plaka, pigmenata i ostataka oralnog tkiva, pa se može smatrati favorizujućim faktorom u nastanku parodontalnih oboljenja i brojnih oralnih infekcija[2-4]. Brojne in vitro i in vivo studije pokazale su da se stomatološki materijali razlikuju po njihovoj podložnosti da adheriraju oralne bakterije[5,6], što se najčešće pripisuje razlikama u hrapavosti podloge i količini slobodne energije[7,8].

Tekstura površine je jako važno pitanje u razumevanju prirode materijala i igra važnu ulogu u njegovim funkcionalnim performansama. Čvrste površine, bez obzira na način njihovog formiranja, sadrže nepravilnosti ili odstupanja od propisanih geometrijskih oblika[9-11]. Nijedan metod obrade, koliko god precizan, ne može da proizvede molekularno ravnu površinu materijala. Čak i najglađe površine, kao što su one dobijene dekompozicijom nekih kristala sadrže nepravilnosti. Teorijski, hrapavost površina stomatoloških materijala treba smanjiti ispod 0,2μm, što je praksi nemoće izvesti[12].

Hrapavost se može karakterisati sa nekoliko parametara i funkcija, kao što je visina, parametri talasnih dužina, parametri razmaka i hibridi[13]. Najvažniji parametri u slučaju hrapavosti su parametri visine.

U ostvarivanju zahteva restaurativne stomatologije, kompozitni materijali neprikosnoveni su u stomatološkoj kliničkoj praksi, pre svega zbog estetskih svojstava, zadovoljavajućih bioloških kvaliteta i prihvatljivih fizičkih i hemijskih karakteristika. Niska hrapavost površine za restauraciju prestavlja osnovni zahtev za integritet parodonta zuba, za marginalni integritet restauracije kao i za njenu dugovečnost[14].

Dentalna staklokeramika se može definisati kao kristalna, neorganska smesa koja otvrdnjava sinterovanjem, ili kao bela, transcelularna smesa koja se pečenjem dovodi u čvrsto i glazirano stanje. Osnova staklokeramike je stakleni matriks sa različitom količinom punioca (litijum disilikat,

Introduction

In order for a material to be considered biocompatible, it is necessary, among other things, to have such a surface design that reacts as little as possible with tissue and environmental agents[1]. The rough surface of acrylate, ceramics and composite materials is a predilection site for the accumulation of plaques, pigments and oral tissue residues, and can, therefore, be considered a favored factor in the onset of periodontal diseases and numerous oral infections[2-4]. Numerous in vitro and in vivo studies have shown that dental materials differ in their susceptibility to adhesion to oral bacteria[5,6], which is most often attributed to differences in surface roughness and amount of free energy[7,8].

Surface texture is a very important issue in understanding the nature of a material and plays an important role in its functional performance. Solid surfaces, irrespective of their method of formation, contain irregularities or deviations from the predetermined geometric shapes[9-11]. No processing method, however precise, can produce a molecularly smooth surface of the material. Even the smoothest surfaces, such as those obtained by the decomposition of some crystals, contain irregularities. Theoretically, the surface roughness of dental materials should be reduced below 0.2μm, which is impossible to perform in practice[12].

Roughness can be characterized by several parameters and functions, such as height, wavelength parameters, spacing parameters, and hybrids[13]. The most important parameters in the case of roughness are the parameters regarding the height.

In meeting the demands of restorative dentistry, composite materials are the best choice in dental clinical practice, primarily because of their aesthetic properties, satisfactory biological qualities, and acceptable physical and chemical characteristics. The low roughness of the restoration surface is a basic requirement for the integrity of the periodontium of the tooth, the marginal integrity of the restoration and its longevity[14].

Dental glass-ceramics can be defined as a crystalline, inorganic compound which is sinter-hardened, or as a white, transcellular mixture that is brought into a solid and glazed state in the chemical oven. The basis of glass-ceramics is a glass matrix with different amounts of fillers (lithium disilicate, leucite or fluorapatite) which give transparent mass favorable mechanical and physical properties.

leucit ili fluoroapatit) koji transparentnoj masi daju povoljna mehanička i fizička svojstva.

Prednost ovih keramičkihsistema je da ne deluju štetno na tkiva i organizam čoveka, elektohemijski su postojni, otporni su na slabija mastikatorna opterećenja, estetski su prihvatljivi i mogu se dobro i relativno jednostavno oblikvati i obrađivati[15].

Cirkonijum oksidna keramika se koristi za izradu radikularnih kočića, CAD-CAM jezgra za krunice i punih cirkonijumskih krunica. Polikristalne je strukruture, uz odsustvo staklenog matriksa, te je izuzettna čvrta i povoljna za nadoknadu zubnih struktura u bočnoj regiji. Sem fizičko-mehaničkih svojstva, poseduje i druge druge karakteristike prihvatljive za stomatologiju: bio-kompatibilnost, elektrohemijska neutralnost, niska korozivnost i boja primerena za imitaciju prirodnih zuba[16].

Zbog svojih dobrih fizičko-mehaničkih svojstva i relativno jednostavnog postupka rada toplo polimerizovani akrilati su već dugo najčešće korišćeni preparati za izradu baze proteze. Po hemijskoj strukturi to su etri metakrilne kiseline, transparentne materije različitog viskoziteta i širokog spektra fizičko-mehaničkih katakteristika, koji se lako boje i obrađuju. Na tržištu su najzastupljeniji kao dvokomponentni preparati (prašak i tečnost)[17].

Hladno polimerizovani akrilati su po hemijskom sastavu identični sa toplo polimerizovanim akrilatima, ali se vezuju na sobnoj temperaturi. Jedina ali bitna razlika je u tome što akrilati za hladnu polimerizaciju sadrže i aktivator koji razlaze inicijator polimerizacije na slobodne radikale odgovorne za početak procesa polimerizacije. Kako se proces polimerizacije hladnopolimerizovanih akrilata odvija vrlo brzo i bez pritiska, to su fizička svojstva ovog akrilata nešto lošija od svojstva toplopolimerizovanih akrilata. Najčešće se primenjuju za izradu baze parcijalne skeletirane proteze i nagriznih grebena, mobilnih ortodontskih aparata, individualne kašike, reparature proteze kao i za izradu modela zubne nadoknade[17].

Cilj istraživanja bio je ispitati i uporediti hrapavost najčešće primenjivanih stomato-loških materijala, primenom mehaničkog profilometra.

The advantage of these ceramic systems is that they do not adversely affect tissues and the human body. Instead, they are electrochemically stable, resistant to low masticatory loads, aesthetically acceptable and can be relatively easily designed and processed[15].

Zirconium oxide is used to make root canal post and cores for crowns using CAD-CAM technology and full zirconium crowns. The polycrystalline structure, in the absence of glass matrices, is extremely solid and suitable for the replacement of dental structures in the lateral region. In addition to the physico-mechanical properties, it also contains other characteristics acceptable for dentistry: biocompatibility, electrochemical neutrality, low corrosivity and color suitable for imitation of natural teeth[16].

Due to their good physical-mechanical properties and relatively simple working process, hot polymerized acrylates have long been the most commonly used preparations for the manufacture of denture bases. By their chemical structure, they are methacrylic acid ethers, transparent substances of different viscosities and a wide range of physico-mechanical characteristics, which are easy to color and process. In the market, they can be found as two-component preparations (powder and liquid)[17].

Cold-polymerized acrylates are identical when it comes to chemical composition to hot polymerized acrylates, but they bind at the room temperature. The only but important difference is that cold polymerized acrylates also contain an activator that decomposes the polymerization initiator into the free radicals responsible for initiating the polymerization process. As the process of polymerization of cold polymerized acrylates takes place very quickly and without pressure, the physical properties of this acrylate are slightly worse than the properties of hot polymerized acrylates. They are most commonly used for the production of partial skeletal dentures and alveolar ridge, removable orthodontic appliances, individual spoons, prosthesis reparations, as well as for dental replacement models[17].

The aim of the study was to examine and compare the roughness of commonly used dental materials using a mechanical profilometer.

Tabela 1. Ispitivani materijali
Table 1. Tested materials

Materijal / Material	**Komercijalni naziv proizvoda / Commercial product name**
Toplo polimerizovani akrilat Hot polymerized acrylate	Triplex Hot, Ivoclar Vivadent, Lihtenštajn
Hladno polimerizovani akrilat Cold polymerized acrylate	Triplex Cold, Ivoclar Vivadent, Lihtenštajn
Hladno polimerizovani akrilat Cold polymerized acrylate	Ortopli, GSK, SAD
Staklokeramika Glass-ceramic	IPS Empress, Ivoclar Vivadent, Lihtenštajn
Cirkonijum oksidna keramika Zirconium oxide ceramic	IPS e.maxZirCAD, Ivoclar Vivadent, Lihtenštajn
Kompozit Composite	Evetric, Ivoclar Vivadent, Lihtenštajn

Materijal i metode

Ispitivani materijal prikazan je u tabeli 1.

Uzorci materijala za su pravljeni prema uputstvu proizvođača, a njihova obrada bila je analogna onoj koja se primenjuje u svakodnevnoj praksi. Uzorci su imali izgled pločica pravougaonog oblika, dimenzija 3x1,5cm, debljine 3mm. Merenje hrapavosti dobijenih uzoraka izvršeno je pomoću Mitutoyo SJ-301 Suftest uređaja, prevlačenjem čitača preko uzoraka, u dva aksijalna pravca međusobno postavljena pod pravim uglom,čime su dobijena dve vrednosti merenja za svaki materijal pojedinačno. Od svakog ispitivanog materijala napravljeno je po tri uzorka.

Merene su dve vrednosti: Ry - maksimalna visina profila i Ra - srednja aritmetička vrednost odstupanja profila. Dobijene vrednosti izražene su u μm.

Statistička obrada podataka uključivala je izračunavanje srednje vrednosti Ry i Ra za ispitivane urorke i njihovih standardnih devijacija, u programu SPSS 15,0.

Material and methods

The tested material is shown in Table 1.

Material samples were made according to the manufacturer's instructions, and their processing was analogous to that applied in everyday practice. The samples had the appearance of rectangular tiles, dimension 3 x 1.5cm, and 3mm thick. The measurement of the roughness of the obtained samples was carried out using a Mitutoyo SJ-301 Suftest device by dragging the reader over the samples, in two axial directions arranged at the right angle, thus obtaining two measurement values for each material individually. Three samples were made of each material tested.

Two values were measured: Ry - maximum profile height and Ra - mean arithmetic value of profile deviation. The values obtained are expressed in μm.

Statistical data processing included the calculation of the mean of the Ry and Ra for the samples tested and their standard deviations, in SPSS 15.0.

Rezultati

Merenjem površinske hrapavosti materijala, utvrđeno je da među ispitivanim uzorcima postoje značajne razlike. Najveća hrapavost izmerena je kod hladno polimerizovanog akrilata, dok je najmanja hrapavost bila kod kompozitnog materijala. Dobijene vrednosti prikazane su u tabelama 2-7.

Results

By measuring the surface roughness of the material, it was found that there were significant differences between the tested samples. The highest roughness was measured with cold polymerized acrylate, while the lowest roughness was found in measuring the composite material. The values obtained are shown in Tables 2-7.

Tabela 2. Vrednosti površinske hrapavosti toplo polimerizovanog akrilata (μm)
Table 2. Surface roughness values of hot polymerized acrylates (μm)

Materijal/ Material	**Uzorak/ Sample**	**Ra**	**Ry**	**Ra X**	**Ra SD**	**Ry X**	**Ry SD**
Toplo polimerizovani akrilat/ hot polymerized acrylate *Triplex Hot*	1	0.27	1.54				
	1	0.28	1.75				
	2	0.22	1.10	0.31	0.08	1.67	0.43
	2	0.24	1.23				
	3	0.44	2.09				
	3	0.39	2.28				

Ry X- srednja aritmetička vrednost maksimalne visine profila

Ry X- mean arithmetic value of maximum profile height

Ra X - srednja aritmetička vrednost iodstupanja profila

Ra X - mean arithmetic value of profile deviation

Ra SD- standardna deviaciona mera, koja se koristi za kvantifikaciju količine varijacije skupa vrednsti odstupanja profila

Ra SD-standard deviation measure used to quantify the amount of variation of a set of profile deviation values

Ry SD – standardna devociona mera, koja se koristi za kvantifikovanje količine varijacije maksimalne visine profila

Ry SD - standard deviation measure used to quantify the amount of variation of the maximum profile height

Tabela 3. Vrednosti površinske hrapavosti hladno polimerizovanog akrilata koji se upotrebljava u stomatološkoj protetici (μm)
Table 3. Surface roughness values of cold polymerized acrylates used in dental prosthetics (μm)

Materijal/ Material	**Uzorak/ Sample**	**Ra**	**Ry**	**Ra X**	**Ra SD**	**Ry X**	**Ry SD**
Hladno polimerizovani akrilat/ Cold polymerized acrylate *Triplex Cold*	1	1.76	8.52				
	1	1.85	8.69				
	2	2.03	9.17	1.91	0.09	8.83	0.42
	2	1.99	8.17				
	3	1.87	8.94				
	3	1.94	9.46				

Tabela 4. Vrednosti hrapavosti hladno polimerizovanog akrilata koji se upotrebljava u ortodonciji

Table 4. Roughness values of cold-cured acrylates used in orthodontics

Materijal/ Material	**Uzorak/ Sample**	**Ra**	**Ry**	**Ra X**	**Ra SD**	**Ry X**	**Ry SD**
Hladno polimerizovani akrilat/ Cold polymerized acrylate *Ortopoli*	1	0.51	2.78				
	1	0.22	2.18				
	2	0.51	3.06	0.43	0.10	2.74	0.45
	2	0.41	2.08				
	3	0.43	3.17				
	3	0.50	3.15				

Tabela 5. Vrednosti površinske hrapavosti staklokeramike (μm)
Table 5. Surface roughness values of glass-ceramics (μm)

Materijal/ Material	**Uzorak/ Sample**	**Ra**	**Ry**	**Ra X**	**Ra SD**	**Ry X**	**Ry SD**
Staklo keramika/ Glass-ceramic IPS Empress	1	0.27	1.23				
	1	0.36	1.96				
	2	0.37	1.76	0.40	0.10	1.87	0.45
	2	0.6	2.46				
	3	0.41	2.35				
	3	0.36	1.43				

Tabela 6. Vrednosti površinske hrapavosti cirkonijum oksidne keramike (μm)
Table 6. Surface roughness values of zirconium oxide (μm)

Materijal/ Material	**Uzorak/ Sample**	**Ra**	**Ry**	**Ra X**	**Ra SD**	**Ry X**	**Ry SD**
Cirkonijum oksidna keramika/Zirconium oxide ceramic IPS e.maxZirCAD	1	0.36	2.98				
	1	0.33	2.91				
	2	0.6	4.11	0.50	0.11	3.45	0.43
	2	0.59	3.85				
	3	0.61	3.5				
	3	0.49	3.33				

Tabela 7. Vrednosti površinske hrapavosti kompozitnog materijala (μm)
Table 7. Surface roughness values of the composite materials

Materijal/ Material	Uzorak/ Sample	Ra	Ry	Ra X	Ra SD	Ry X	Ry SD
Kompozit/ Composie	1	0.18	1.08				
	1	0.24	1.47				
Evetric	2	0.22	1.31	0.21	0.06	1.28	0.41
	2	0.13	0.8				
	3	0.31	2.05				
	3	0.17	0.97				

Diskusija

Neravna površina stomatoloških materijala predstavlja predilekciono mesto za akumulaciju plaka, pigmenata i ostataka oralnog tkiva. Iz tih razloga, obavezna je besprekorna higijena zuba na kojima postoje plombe, veštačke krunice i mostovi, kao i mobilnoh proteza. Obzirom na njihovu višedecenijsku ulogu morfološkog i funkcionalnog supstituenta u usnoj duplji, većina od ovih materijala zadovoljava uslove koje je pred njih postavila struka. Ipak, postoji puno prostora za njihovo unapređenje, kako im uloga u usnoj duplji ne bi bila prevashodno mehanička, ili drugim rečima terapijska, već preventivna u svom pravom značenju.

Problem protetskog stomatita (stomatitis protetica) javlja se kod 60 do 65% nosioca akrilatnih zubnih proteza[5,6]. U velikom broju slučajeva njegova etiologija vezuje se za akumulaciju gljiva roda Candida na površini akrilata i tada je praćen suvoćom, pečenjem i žarenjem u ustima[7]. Lyon i Chick su kliničkom studijom dokazali da kandide ima više na akrilatnoj protezi nego na oralnoj sluzokoži pacijenta obolelog od protetskog stomatita[7]. To se, sa sigurnošću može pripisati i površinskoj strukturi ovog materijala, koja je reda veličine medijane hrapavosti: Ry=1,17 za toplopolimerizovani akrilat odnosno Ry=8,83

Discussion

The rough surface of dental materials is a predilection site for the accumulation of plaque, pigments, and oral tissue residues. For these reasons, appropriate dental hygiene of the teeth with fillings, artificial crowns, and bridges, as well as mobile dentures is mandatory. Due to their decades-long role as a morphological and functional substitute in the oral cavity, most of these materials satisfy the rules set by the profession. However, there is a lot of room for improvement, so that their role in the oral cavity is not primarily mechanical, or in other words therapeutic, but preventive in its true meaning.

The problem of prosthetic stomatitis occurs in 60 to 65% of acrylic denture wearers[5,6]. In many cases, its etiology is related to the accumulation of Candida yeasts on the acrylic surface followed by a sense of dryness and burning in the mouth[7]. Lyon and Chick have proven that Candida is located on most of the acrylic prosthesis than on the oral mucosa of a patient with prosthetic stomatitis[7]. This can certainly be attributed to the surface structure of this material, which is of the order of magnitude

(hladno polimerizovani akrilat). Pravilnom pripremom materijala, kao i adekvatnim poliranjem, znatno se smanjuje njegova ukupna površina, pa i mogućnost da se kandida i drugi mikroorganizmi za nju zalepe. Hladno polimerizovani akrilati su pokazali izrazito veće vrednosti hrapavosti u odnosu na akrilat koji se polimerizuje u ključaloj vodi, te njihovu upotrebu treba izbegavati kada su u pitanju podlaganja i reparature zubnih proteza. Obzirom da se hladno polimeruzovani akrilati koriste i za izradu mobilnih ortodontskih aparata, njih pre upotrebe treba ispolirati po protokolu i besprekorno održavati, kako bi se poboljšala njihova biološka svojstva (Ry=2,27).

Srednja vrednost površinske hrapavosti ispitivanog kompozitnog materijala bila je Ry=1,28, što je najmanja izmerena vrednost u odnosu na druge ispitivane materijale. Literaturni podaci su pokazali da kompozitne restauracije akumuliraju više plaka u odnosu na druge vrste stomatoloških materijala[18-21]. Nepotpuna obrada i konsekutivna hrapavost kompozitnih materijala značajno doprinose nakupljanju biofilma na površini kompozita [22,23]. U uslovima usne duplje kompozitni materijali se vremenom degradiraju, što uslovljava srazmerno povećanje njihove hrapavosti i adherencije biofilma. Kolonizacija prostora između zuba i kompozitne restauracije smatra se glavnim uzrokom nastanka sekundarnog karijesa[24].

Nakupljanje biofilma na keramičkim krunicama i inlejima može rezultovati oštećenjima potpornog aparata zuba i razvojem karijesa, te je održavanje oralne higijene kod pacijenata sa ovim vrstama nadoknada imperativ. Rashid i Kawai i sar. su zaključili da glazirana keramika usled postojanja mikrohrapavosti nakuplja više plaka u odnosu na keramiku poliranu dijamantskom pastom [25-27]. Ispitivani uzorci staklokeramike bili su ispolirani, a srednja vrednost hrapavosti iznosila je Ry=1,87μm, što je neznatno više u odnosu na ispolirani kompozit i toplopolimerizovani akrilat. Sa druge strane, hrapavost cirkonijum oksidne keramike bila je viša od očekivane sa medijanom od Ry=3,45μm. Obzirom na mali broj istraživanja u vezi sa biokompatibilnošću ove vrste materijala na ovom nivou nismo u mogućnosti da komentarišemo značajno veću hrapavost

of the median roughness: Ry = 1.17 for hot polymerized acrylate and Ry = 8.83 (cold polymerized acrylate). Proper preparation of he material, as well as adequate polishing, significantly reduces its total surface area, as well as the possibility of adhesion of Candida and other microorganisms to it. Cold polymerized acrylates have shown markedly higher roughness values than acrylate polymerized in boiling water, and their use should be avoided when it comes to relining and reparations. Since cold polymerized acrylates are also used in the manufacture of removable orthodontic appliances, they must be polished prior to use and maintained in order to improve their biological properties (Ry = 2.27).

The mean of the surface roughness of the tested composite material was Ry = 1.28, which is the lowest measured value compared to the other tested materials. Literature data have shown that composite restorations accumulate more plaque than other types of dental materials[18-21]. Incomplete processing and consecutive roughness of composite materials significantly contribute to the biofilm accumulation on the composite surface[22,23]. In the oral cavity, composite materials degrade over time, which causes a proportional increase in their roughness and adhesion of the biofilm. Colonization of the space between the tooth and the composite restoration is considered to be a major cause of secondary caries[24].

The accumulation of a biofilm on ceramic crowns and inlays can result in damage of the supporting apparatus of the teeth and the development of caries, so the maintenance of oral hygiene in patients with these types of restoration is imperative. Rashid and Kawai et al. have concluded that due to the presence of micro-roughness, glazed ceramics accumulate more plaque than ceramics polished by diamond paste [25-27]. The tested samples of glass-ceramics were polished, with a mean roughness of Ry = 1.87 μm, which was slightly higher than the polished composite and the hot polymerized acrylate. On the other hand, the roughness of zirconium oxide was higher than expected with a median Ry = 3.45 μm. Due to the small number of research regarding the biocompatibility of this type of material, we

cirkonije u odnosu na konvencionalno pripremljenu staklokeramiku. Uporedna analiza kvaliteta površinske strukture različitih keramika biće predmet budućih istraživanja, a i sama praksa će pokazati kako će se ove restauracije novije generacije vremenom ponašati prema okolnim tkivima.

Pljuvačka svojim protokom, puferskim kapacitetom i promenom sastava omogućava dinamičnu interakciju materijalima implementiranim u usnu duplju, čime utiče na njihove karakteristike, uključujući i adherentnost[28-29]. Sve nadoknade su u ustima pacijenta obložene salivarnom pelikulom, omotačem koji nastaje međusobnom interakcijom materijala i sastojaka pljuvačke. Ključnu ulogu u njenom formiranju igra precipitacija mucina i glikoproteina pljuvačke [30]. Sam sloj pljuvačke smanjuje adherentnost dentalnog plaka i ostataka hrane za površinu materijala, te im ovaj prirodni omotač poboljšava biokompatibilnost.

Zaključak

Predložena metoda za merenje hrapavosti stomatoloških materijala je jednostavna i ne zahteva skupo istraživanje. Dobijeni rezultati, upoređeni su sa merenjima koja su rađena u dva pravca, jednostavnom analizom otkrivena je statistički značajna razlika stepena hrapavosti. Uzimajući u obzir ograničenja prilikom istraživanja, na osnovu merenja, možemo izvesti sledeće zaključke: najveća hrapavost je kod hladno-polimerizovanog akrilata, dok je najmanja kod kompozitnih materijala. Preliminarni rezultati predstavljaju osnovu za istraživanja ponašanja različitih materijala u kliničkim uslovima.

are not able to comment on the significantly higher zirconium roughness compared to conventionally prepared glass-ceramics. A comparative analysis of the quality of the surface structure of different ceramics will be the subject of future research, and the practice itself will show how these new-generation restorations will behave to the surrounding tissues.

Saliva, through its flow, buffering capacity, and composition change allows dynamic interaction with materials implemented in the oral cavity, thereby affecting their characteristics, including the adherence[28-29]. All restorations are coated with a salivary pellicle, a cover formed by the interaction of saliva material and constituents. A key role in its formation is played by the precipitation of saliva mucin and glycoproteins[30]. The saliva layer itself reduces the adherence of dental plaque and food residues to the surface of the material, and this natural cover enhances their biocompatibility.

Conclusion

The proposed method for measuring the roughness of dental materials is simple and does not require expensive research. The results obtained were compared with measurements that were made in two directions, and a simple analysis revealed a statistically significant difference in the degree of the roughness. Considering the limitations of the research, based on measurements, we can draw the following conclusions: the highest roughness is found in cold polymerized acrylate, while the lowest in the case of composite materials. The preliminary results form the basis for investigating the behavior of different materials under clinical conditions.

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