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Martin Pavlin[1], Nenad Gubeljak[2], Jožef Predan[2], Robert Ćelić[3]

Evaluation of the Bond Strength between the Acrylic Teeth and Reinforced or Non-reinforced Complete Denture Base

Ispitivanje snage veze između akrilatnih zuba i pojačane ili nepojačane baze potpune proteze

[1] Tindens Dental Clinic, Maribor, Slovenia.
Dentalna klinika Tindens, Maribor, Slovenija
[2] Department of Mechanics, Faculty of Mechanical Engineering, University of Maribor, Slovenia.
Zavod za mehaniku Strojarskoga fakulteta Sveučilišta u Mariboru, Slovenija
[3] Department of Removable Prosthodontics, School of Dentistry, Zagreb, Croatia.
Zavod za mobilnu protetiku Stomatološkog fakulteta Sveučilišta u Zagrebu, Hrvatska

Abstract

Objective: The aim of this study was to examine whether the method of surface treatment of the acrylic teeth and reinforcement of the denture base (carbon fibers) affect the reduction of stress concentration for gap initiation at the interface of acrylic teeth and denture base as a measure of bond strength. **Materials and methods:** Samples of cross-sections of acrylic teeth and denture base were isolated from four pairs of complete acrylic dentures (with and without reinforcement of the denture base) and were subsequently subjected to compressive loading in a universal testing machine simulating two different occlusions. Selected groups of acrylic teeth (central incisors, first premolars, and first molars) from complete dentures were treated in various ways (untreated, mechanical, chemical, and mechanical-chemical). The gap size at the interface of acrylic tooth and denture base was measured using a light inverted microscope on selected acrylic teeth of individual quadrants. The one-way analysis of variance was used to investigate the influence of denture base reinforcement and different methods of surface treatment of the acrylic tooth on bond strength at the level of statistical significance of $p \leq 0.001$. **Results:** Microscopic analysis of gap size measured at five selected points at the interface between the acrylic teeth and the base of the complete denture ranged from 40 to 144 micrometers. The one-way analysis of variance showed a statistically significant difference between the arithmetic means of the measured gap sizes concerning different methods of surface treatment of the acrylic teeth. **Conclusion:** The fracture strength, or load-bearing capacity, of complete dentures reinforced with carbon fibers was increased compared to complete dentures with non-reinforced bases. Reduction in gap size at the interface between the acrylic teeth and the base of complete dentures was influenced by the mechanical-chemical treatment of the lower surface of acrylic teeth, while reinforcement of the complete denture base with carbon fibers had no effect on the bond strength.

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Address for correspondence
Professor Robert Ćelić, PhD
University of Zagreb
School of Dental Medicine
Department of Removable Prosthodontics
Gundulićeva 5, 10 000 Zagreb
celic@sfzg.hr

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Martin Pavlin: 0009-0006-5256-4520
Nenad Gubeljak: 0000-0002-3276-8431
Jožef Predan: 0000-0002-3976-9437
Robert Ćelić: 0000-0002-5197-3465

Introduction

A classic problem or weak point of acrylic complete and partial dentures is the high incidence of fractures in the denture base itself, as well as in the interface area between acrylic teeth and the denture base (about 30%). The most common reasons for these fractures include lower mechanical properties of PMMA acrylic; structural differences between prefabricated acrylic teeth and base acrylics due to variations in factory production; the use of different technological processes in denture fabrication (e.g., compression molding, microwave, light, and injection polymerization; CAD/CAM and 3D printing); misaligned occlusion (presence of premature occlusal contacts on dentures); unskilled dental technician work; and careless patient handling (1-4).

Uvod

Klasičan problem ili slaba karika akrilatnih potpunih i djelomičnih proteza jest visoka pojavnost lomova same baze proteze, ali i u području spojeva između akrilatnih zuba i baze proteze (oko 30 %). Najčešći razlozi za to su slabija mehanička svojstva PMMA akrilata, strukturne razlike tvorničkih akrilatnih zuba i akrilata za baze nastale zbog razlika u tvorničkoj proizvodnji, upotreba različitih tehnoloških postupaka pri izradi akrilatnih proteza (npr., tlačno-toplinska, mikrovalna, svjetlosna i injekcijska polimerizacija; CAD/CAM i 3D izrada), neusklađena okluzija (prisutnost preranih okluzijskih zubnih dodira na protezama), nestručan rad zubnog tehničara te nepažljivo rukovanje pacijenta (1 – 4).

In scientific *in-vitro* studies, the most common factors affecting the mechanical properties of standardized samples of the base and interface between acrylic teeth and denture base are various technological processes used in sample fabrication, different methods of preparing the lower surface of acrylic teeth, and reinforcement of the denture base. Yadav et al. (5) investigated whether the type of polymerization affects the bond strength between acrylic teeth and denture base. The results showed better bond strength in samples obtained through conventional heat-cured compression molding in a water bath compared to microwave polymerization. They also noted that fractures more commonly occurred in the body of the acrylic tooth rather than at the interface between the acrylic tooth and denture base. Andrade de Freitas et al. (6) tested the shear bond strength between different types of artificial acrylic teeth (from four manufacturers) and two types of polymerizations (heat-cured compression molding and microwave) during thermocycling. The results showed that the shear bond strength at the interface between acrylic teeth and denture base was stronger with microwave polymerization compared to heat-cured compression molding, while the thermocycling process did not weaken the bond at the interface between acrylic teeth and denture base.

Studies (7-11) have been published examining various methods of mechanical preparation of acrylic teeth and their influence on the quality and strength of the bond at the interface between acrylic teeth and the denture base. Vallittu and Ruyter (7) confirmed the positive effect of mechanical surface treatment of acrylic teeth on increasing the bond quality between acrylic teeth and the denture base. They have recommended roughening the surface and creating grooves (3.5 mm in length) on the approximal surfaces of prefabricated acrylic teeth. Pispili et al. (10) investigated the impact of different combinations of mechanical (no treatment, air abrasion with Al_2O_3 particles) and chemical treatments (phosphoric acid etching; application of composite adhesive agents; application of methyl methacrylate and ethyl methyl ketone adhesives; polymethyl methacrylate monomer) on the surface of acrylic teeth bonded to the denture base. The strongest bond strength was recorded in the group treated with sandblasting (air abrasion) combined with PMMA monomer, as well as other chemical agents or adhesives.

In addition to the surface treatment of acrylic teeth, scientific studies (12-18) have been published addressing the influence of reinforcing the denture base with various mechanically stronger materials than acrylic base "strengtheners" (metal mesh, carbon mesh, glass fibers, polyethylene fibers, PMMA fibers, kevlar fibers, aramid fibers, aluminum oxide, titanium oxide, zirconium oxide, nylon, hybrid fibers, and numerous other "strengtheners"). The results of these mostly *in-vitro* studies generally indicate that the use of reinforcements to strengthen the bases of conventional acrylic dentures improves mechanical properties such as fracture strength, compressive strength, tensile strength, flexural strength, toughness, etc.

Acrylic teeth and the denture base as load-bearing structures are subjected to various stresses during function, compression, tension, shear, and torsion, which can lead to frac-

U znanstvenim studijama *in vitro* najčešći čimbenici koji utječu na mehanička svojstava na standardiziranim uzorcima baze i spoja akrilatnih zuba i baze proteze jesu različiti tehnološki procesi izrade uzoraka, različiti načini pripreme donje površine akrilatnih zuba i pojačanja baze proteze različitim pojačivačima. Yadav i suradnici (5) istraživali su utječe li vrsta polimerizacije na snagu veze između akrilatnih zuba i baze proteze. Rezultati su pokazali bolju snagu veze na uzorcima koji su bili dobiveni u konvencionalnoj toplinsko-tlačnoj polimerizaciji u vodenoj kupki u odnosu na mikrovalnu polimerizaciju. Također ističu da se lom češće događao u samom tijelu akrilatnoga zuba prije nego na spoju između akrilatnoga zuba i baze proteze. Andrade de Freitas i suradnici (6) testirali su snagu veze smicanja između različitih tipova umjetnih akrilatnih zuba (četiri proizvođača) i dviju vrsta polimerizacije (toplinsko-tlačna i mikrovalna) u procesu termocikliranja. Rezultati su pokazali da je snaga veze smicanja na spoju akrilatnoga zuba i baze bila snažnija kod mikrovalne polimerizacije u odnosu prema toplinsko-tlačnoj, a proces termocikliranja nije utjecao na slabljenje veze na spoju akrilatnoga zuba i baze.

Objavljene su studije (7 – 11) u kojima su autori ispitivali različite načine mehaničke pripreme akrilatnoga zuba i njihov utjecaj na kvalitetu i snagu veze na spoju akrilatnoga zuba i baze. Vallittu i Ruyter (7) potvrdili su pozitivan utjecaj načina mehaničke obrade površine akrilatnoga zuba na povećanje kvalitete veze akrilatnoga zuba s bazom proteze. Preporučuju da se površina nahrapavi i naprave utori (dužine 3,5 mm) na aproksimalnim površinama tvorničkih akrilatnih zuba. Pispili i suradnici (10) ispitivali su utjecaj različitih kombinacija mehaničke (bez obrade, zračna abrazija česticama Al_2O_3) i kemijske obrade (jetkanje fosfornom kiselinom, primjena adhezivnog sredstava za kompozite, primjena metilmetakrilata i etilmetilketona adheziva, polimetilmetakrilata monomera) površine akrilatnoga zuba koji se vezao u akrilatnu bazu proteze. Najjača snaga veze bila je zabilježena u skupini tretiranoj pjeskarenjem (zračna abrazija) u kombinaciji s PMMA monomerom, ali i drugim kemijskim agensima ili adhezivima.

Osim načina obrade površine akrilatnoga zuba, objavljena su znanstvena istraživanja (12 – 18) koja se bave utjecajem ojačanja baze proteze različitim sredstvima mehanički čvršćima od akrilatne baze ojačane pojačivačima (metalna mrežica, karbonska mrežica, staklasta vlakna, polietilenska vlakna, PMMA vlakna, kevlarska vlakna, aramidna vlakna, aluminijev oksid, titanijev oksid, cirkonijev oksid, najlon, hibridna vlakna i mnogobrojni drugi pojačivači). Rezultati tih pretežno studija *in vitro* najčešće pokazuju da upotreba ojačivača za pojačanje baza konvencionalnih akrilatnih proteza poboljšava mehanička svojstva poput otpornosti na lom, tlačne čvrstoće, vlačne čvrstoće, savojne čvrstoće, žilavosti, itd.

Akrilatni zubi i baza potpune proteze, kao nosive konstrukcije, podvrgnuti su različitim stresovima tijekom funkcije: tlačenju, istezanju, smicanju i torziji koji mogu završiti lomom. Uz to, mehanički čimbenici poput različitih vrijednosti i veličina žvačnog opterećenja, razlika u viskoelastičnosti i nejednakoj debljini sluznice, odsutnost točne osi simetritures. Additionally, mechanical factors such as different values and sizes of masticatory loads, differences in viscoelasticity and uneven mucosal thickness, the absence of an exact axis of symmetry, and uneven base thickness of complete dentures are factors that complicate conducting studies in clinical conditions on this topic (19, 20).

The complete acrylic denture must possess good mechanical properties to withstand functional demands; therefore, fracture strength is one of the most important mechanical properties. Prombonas et al. (20) measured the fracture strength of upper complete dentures and investigated the influence of different forms (deep or shallow) of notches on the acrylic base of the upper denture on fracture strength. They concluded that deep notches in the base of the upper acrylic denture in the region of the upper lip frenulum significantly reduced the measured values of fracture strength. They have suggested that this drawback can be prevented by reinforcing the base of the acrylic denture.

The aim of this study was to measure the fracture strength of the tested complete dentures (with and without base reinforcement) subjected to compressive loading in simulated eugnathic and progenic occlusal contacts in a universal testing machine. Microscopic analysis aimed to determine the quality of the bond at the interface between the acrylic tooth and the denture base by measuring the size of the gap at the mentioned interface concerning different methods of acrylic tooth treatment (no treatment, mechanical treatment, chemical treatment, mechanical and chemical treatment) and base reinforcement (with and without carbon fibers). The null hypothesis of the study was that the method of acrylic tooth treatment and base reinforcement does not affect the reduction in the size of the gap at the interface between the acrylic tooth and the denture base.

Materials and methods

In order to investigate the fracture strength of acrylic complete dentures and the quality of the bond between the acrylic teeth and the denture base, a total of four pairs of complete dentures were fabricated, all of which were geometrically identical. To achieve this, the clinical situation of an edentulous patient was utilized, and their edentulous alveolar ridges were used to create four identical pairs of complete dentures. These complete dentures were fabricated using the high-pressure heat polymerization technique with the conventional flasking method. Two pairs of complete dentures were fabricated without base reinforcement. The other two pairs of complete dentures, or rather their bases, were fabricated by adding a carbon mesh, which served to mechanically reinforce the properties of the acrylic base. A mesh made of carbon fibers (Figure 1) was used, which was placed in the base of the complete dentures before the start of the flasking process.

Prefabricated acrylic teeth Gnathostar (Ivoclar Vivadent, Schaan, Liechtenstein) were used for setting the teeth in to the complete dentures, and a heat-polymerizing acrylic material ProBase HOT (Ivoclar Vivadent, Schaan, Liechtenstein) was used for the polymerization of the denture base.

je te neujednačene debljine baza potpune proteze čimbenici su koji otežavaju provođenje studija u kliničkim uvjetima o toj tematici (19, 20). Potpuna akrilatna proteza mora posjedovati dobra mehanička svojstva da bi izdržala funkcijske zahtjeve i zato je otpornost na lom jedno od najvažnijih mehaničkih svojstava. Prombonas i suradnici (20) mjerili su otpornost na lom gornjih potpunih proteza i ispitivali utjecaj različitih oblika (dubokih ili plitkih) udubina na akrilatnoj bazi gornje proteze na otpornost na lom. Zaključili su da duboka udubina u bazi gornje akrilatne proteze u području frenuluma gornje usnice značajno smanjuje mjerene vrijednosti otpornosti na lom. Ističu da se taj nedostatak može spriječiti pojačanjem baze akrilatne proteze.

Svrha istraživanja bila je izmjeriti otpornost na lom na testiranim potpunim protezama (bez pojačanja baze i s pojačanjem baze) koje su tlačno opterećivane u simuliranim eugnatim i progenim okluzijskim kontaktima u univerzalnom testnom uređaju. Mikroskopskom analizom željela se ustanoviti kvaliteta veze na spoju akrilatnoga zuba i baze proteze mjerenjem veličine pukotine na navedenome spoju s obzirom na različite načine obrade akrilatnoga zuba (bez tretmana, mehanička obrada, kemijska obrada, mehanička i kemijska obrada) i pojačanje baze (bez karbonskih vlakana i s karbonskim vlaknima). Nulta hipoteza istraživanja bila je da način obrade akrilatnih zuba i pojačanje baze ne utječu na smanjenje veličine pukotine na spoju akrilatnoga zuba i baze proteze.

Materijal i metode

U svrhu ispitivanja otpornosti na lom akrilatnih potpunih proteza i kvalitete veze između akrilatnih zuba i baze proteze pripremljena su ukupno četiri para geometrijski sasvim jednakih potpunih proteza. Za to se iskoristila klinička situacija jednoga bezuboga pacijenta čiji su bezubi alveolarni grebeni poslužili za izradu četiriju istovjetnih parova potpunih proteza. Potpune proteze izrađivane su postupkom tlačno-toplinske polimerizacije klasičnom metodom kivetiranja. Dva para bila su izrađena bez pojačanja baze proteze. Drugim dvama parovima potpunih proteza, odnosno njihovim bazama, bile su dodane karbonske mrežice koje su imale zadaću mehanički pojačati svojstva akrilatne baze. Od karbonskih vlakana napravljena je mrežica (slika 1.) koja je postavljena u bazu potpunih proteza prije početka tehnološkog postupka kivetiranja.

Za postavu zuba u potpunim protezama korišteni su tvornički akrilatni zubi Gnathostar (Ivoclar Vivadent, Schaan, Lihteštajn), a za polimerizaciju baze akrilatni toplopolimerizirajući materijal ProBase HOT (Ivoclar Vivadent, Schaan, Lihteštajn).

Donje površine akrilatnih zuba, koje se obrađuju i dolaze u doticaj s akrilatnom bazom (tijestom) u potpunim prote-

The base surfaces of the acrylic teeth, which were processed and met the acrylic resin in complete dentures, were treated in four different ways and placed in four quadrants: Factory unaltered acrylic teeth (no surface treatment of the acrylic teeth): (acrylic teeth placed in the upper right quadrant). Roughened acrylic teeth with burrs: (acrylic teeth placed in the upper left quadrant). Acrylic teeth moistened with monomer: (acrylic teeth placed in the lower right quadrant). Roughened with burrs and acrylic teeth moistened with monomer: (acrylic teeth placed in the lower left quadrant).

All four pairs of complete dentures were subjected to mechanical compressive loading in a universal testing machine in two dental positions: in maximum intercuspation (eugnathic) and in tete-a-tete (progenic occlusal contact) to simulate occlusal contacts occurring during masticatory function.

The compressive testing of the complete dentures was performed using a universal testing machine, a servo-hydraulic testing system, Instron 1255 (INSTRON, Norwood, USA), for static and dynamic material testing, mechanical components, and structural parts. To monitor deformations on the surface of the dentures in eugnathic and progenic occlusal contacts, a stereo-optical system ARAMIS 2M (GOM m.b.H, Braunschweig, Germany) was utilized. The Aramis system simultaneously captured force and displacement data from the INSTRON machine via cable, while digitally photographing the prosthesis surface with two digital cameras within a 52x35 mm frame containing 2 million points (pixels) and recalculated the position of these points at time intervals of 0.25 seconds. The result was recorded in the form of photographs and videos synchronized with the force-displacement curve in the INSTRON testing machine. In this way, changes in force and displacement can be correlated with individual photographs or events between two photographs taken at intervals of 0.25 seconds.

The complete dentures were mounted on gypsum models made of hard plaster and placed in the INSTRON 1255 testing machine to undergo compressive loading in eugnathic (Figure 2) and prognathic occlusal contacts of the upper and lower acrylic teeth in the complete dentures.

The initial force applied to the dentures was 1 N. The applied force increased until the point of deformation and fracture of the dentures or teeth therein. The loading rate was 10 mm/min. The force increased from the initial 1 N to fracture points at values up to 20 kN. Figure 3 illustrates an example of a fractured complete denture after compressive loading in the INSTRON 1255 testing machine.

Based on this mechanical testing, the fracture strength of the complete dentures was measured to determine the maximum force or stress the complete dentures could withstand before fracture in the region of the acrylic teeth, at the interface of the acrylic teeth and the base, and the bases of the complete dentures themselves. The results of these tests provide insight into the structural integrity of the complete dentures and help identify areas for improvement in their design or fabrication process.

zama, bile su tretirane na četiri načina i smještene u četirima kvadrantima: tvornički nepromijenjeni akrilatni zubi (nema obrade površine akrilatnoga zuba): (akrilatni zubi postavljeni u gornji desni kvadrant): nahrapavljeni akrilatni zubi brusnim svrdlima: (akrilatni zubi postavljeni u gornji lijevi kvadrant); akrilatni zubi navlaženi monomerom: (akrilatni zubi postavljeni u donji desni kvadrant); nahrapavljeni svrdlima i monomerom navlaženi akrilatni zubi: (akrilatni zubi postavljeni u donji lijevi kvadrant).

Sva četiri para potpunih proteza bila su podvrgnuta mehaničkom tlačnom opterećenju u univerzalnom uređaju (kidalici) u dvama zubnim položajima: u eugnatim (maksimalna interkuspidacija) i progenim (tete-a-tete) okluzijskim dodirima sa svrhom imitiranja zubnih dodira koji se događaju tijekom žvačne funkcije.

Tlačno testiranje potpunih proteza bilo je obavljeno u univerzalnom uređaju, servohidrauličnoj kidalici Instron 1255 (INSTRON, Norwood, SAD) za statičko i dinamičko testiranje materijala, strojnih elemenata i dijelova konstrukcija. Za praćenja deformacija na površini proteza u eugnatim i progenim okluzijskim kontaktima korišten je stereo-optički sustav ARAMIS 2M (GOM m.b.H, Braunscheweig, Njemačka). Sustav Aramis je putem kabela zahvaćao podatke o sili i pomaku s kidalice INSTRON, a istodobno je dvjema digitalnim kamerama fotografirao površinu proteze u okviru 52 x 35 mm s 2 milijuna točaka (piksela) te preračunavao položaj tih točaka u vremenskim razmacima od 0,25 sekunde. Konačni rezultat zabilježen je u obliku fotografija i filma koji su vremenski usklađeni s krivuljom sila-pomak u kidalici INSTRON. Na taj se način promjenu sile i pomaka može povezati s pojedinačnom fotografijom, odnosno događajem između dviju fotografija koje su snimljene u razmaku od 0,25 sekunde.

Potpune proteze bile su namještene na modele izrađene od tvrde sadre i postavljene u kidalicu INSTRON 1255 kako bi se mogle podvrgnuti tlačnom opterećenju u eugnatom (slika 2.) i progenom zubnom odnosu gornjih i donjih akrilatnih zuba u potpunim protezama.

Početna sila kojoj su proteze bile izložene iznosila je 1 N. Primjenjivana sila rasla je do točke u kojoj se pojavila deformacija i pucanje proteza ili zuba u njima. Brzina opterećenja bila je 10 mm/min. Sila je tako od početnoga 1 N rasla do granice pucanja na vrijednostima do 20 kN. Na slici 3. primjer je polomljene potpune proteze poslije tlačnoga opterećenja u kidalici INSTRON 1255.

Na temelju toga mehaničkog testiranja mjerila se *otpornost na lom* na potpunim protezama kako bi se izmjerila maksimalna sila ili stres koju potpune proteze mogu podnijeti prije njezina loma u području akrilatnih zuba, na spoju akrilatnih zuba i baze i same baze potpunih proteza. Rezultati tih testiranja omogućuju uvid u strukturalni integritet potpunih proteza i pomažu otkriti područja poboljšanja u njezinu dizajnu ili procesu izrade.

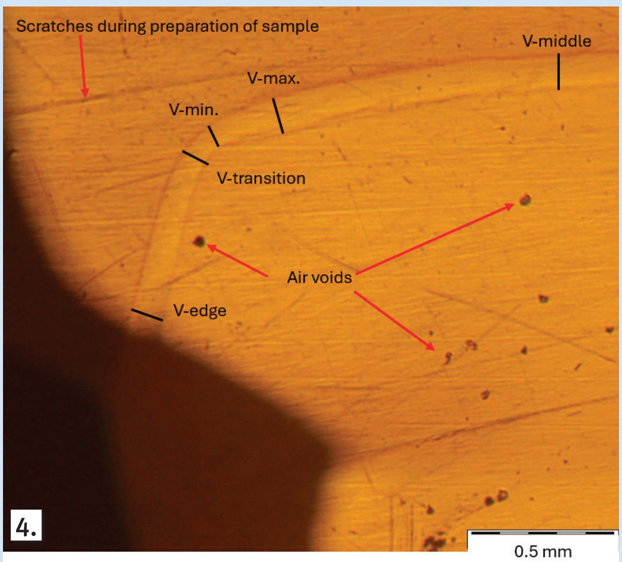

Figure 1 Laboratory fabrication of upper and lower complete dentures reinforced with carbon mesh prepared for flasking procedure.
Slika 1. Prikaz laboratorijske izrade gornje i donje potpune proteze s pojačanjem (karbonska mrežica) – pripremljene su za postupak kivetiranja
Figure 2 The complete dentures on stone models were subjected to compression testing using an INSTRON 1255 universal testing machine.
Slika 2. Potpune proteze na modelima od tvrde sadre u kidalici INSTRON 1255 tijekom tlačnog opterećivanja
Figure 3 Display of complete dentures after compression testing in the INSTRON testing machine.
Slika 3. Prikaz potpunih proteza nakon tlačenja u kidalici INSTRON
Figure 4 Display of the five measuring points at the interface of acrylic tooth and base - sample view for microscopic analysis of gap size measurement."
Slika 4. Prikaz pet mjernih točaka na spoju akrilatni zub i baza – prikaz uzorka za mikroskopsku analizu mjerenja veličine pukotine

Microscopic analysis of the gap size at the interface of the acrylic teeth and denture base

Measurements of gap size using a light microscope at the interface of the acrylic base and acrylic teeth were conducted on samples obtained from complete dentures with (carbon fibers) and without reinforcement that were fractured under compressive loading in the testing machine in simulated eugnathic and progenic occlusal contact. Figure 4 depicts a prepared sample/cross-section of the interface of the acrylic base and acrylic teeth and the locations of five measurement points (V-edge; V-transition; V-middle; V-max.; and V-min) on the gap at the interface. Samples from the fractured test complete dentures, with or without reinforcement, were taken at positions of the upper and lower central incisors [11, 21, 31, 41]; upper and lower first premolars [14, 24, 34, 44]; and upper and lower first molars [16, 26, 36, 46]. The acrylic teeth from the test complete dentures were halved along the midline using a slow-rotating saw. This resulted in samples/cross-sections depicting the interface of the acrylic base and

Mikroskopska analiza veličine pukotine na spoju akrilatnih zuba i baze proteze

Mjerenja veličine pukotine svjetlosnim mikroskopom na spoju akrilatne baze i akrilatnih zuba obavljena su na uzorcima/presjecima dobivenima iz potpunih proteza s pojačanjem (karbonska vlakna) i bez njega koje su bile polomljene tlačnim opterećivanjem u kidalici u simuliranom eugnatom i progenom zubnom dodirnom odnosu. Na slici 4. je pripremljeni uzorak/presjek spoja akrilatne baze i akrilatnih zuba i mjesta pet mjernih točaka (V-rub, V-prijelaz, V-sredina, V-maks,, i V-min.) na pukotini spoja. Uzorci iz testnih/polomljenih potpunih proteza s pojačanjem ili bez pojačanja uzeti su na pozicijama gornjih i donjih desnih i lijevih središnjih sjekutića [11, 21, 31, 41]; gornjih i donjih desnih i lijevih prvih pretkutnjaka [14, 24, 34, 44]; i gornjih i donjih desnih i lijevih prvih kutnjaka [16, 26, 36, 46]. Navedeni akrilatni zubi iz testnih potpunih proteza prepolovljeni su po sredini s pomoću sporortirajuće pile. Tako su dobiveni uzorci/presjeci koji prikazuju spoj akrilatne baze i akrilatnih zuba. Pri-acrylic teeth. Prior to examination under a light microscope, the samples/cross-sections were polished.

By measuring the gap size at the interface of the acrylic base and acrylic teeth using a light microscope in complete dentures with (carbon fibers) or without base reinforcement, the aim was to test whether different methods of preparing the surface of the acrylic teeth (no treatment; mechanical treatment; chemical treatment; and mechanical-chemical treatment) influenced the strength of the bond at that interface (gap size at the interface). The description of the five measurement points on the gap at the acrylic base and acrylic teeth is as follows (Figure 4): V-edge: Thickness of the gap and deformation measured at the edge of the interface - measurement point 1; V-transition: Location of the transition from the horizontal part to the vertical part - measurement point 2; V-middle: Measurement of horizontal gap and deformation at the middle of the gap - measurement point 3; V-max: Maximum measured thickness of the gap and deformation - measurement point 4; V-min: Minimum thickness of the gap and deformation - measurement point 5.

The gap size was measured using a Keyence VHX-7000 digital microscope (Keyence International, Mechelen, Belgium) on selected teeth in each quadrant. Each surface was observed under the microscope at 70x magnification.

The methods of treating the lower surface of the acrylic teeth, which meets the acrylic base during the compression molding process, were as follows: a - untreated acrylic tooth surface; b - mechanical treatment (roughening); c - chemical treatment (coating with monomer); and d - mechanical and chemical treatment (roughening and coating with monomer of the lower surface of acrylic teeth).

The acrylic teeth are labeled with a number indicating the position of the tooth in the complete denture with (O) or without (R) reinforcement (carbon fibers) subjected to compressive loading in eugnathic (EO) and progenic (PO) occlusal relationships until fracture of the dentures (EOO: eugnathic occlusion complete denture without fibers; POO: progenic occlusion complete denture without fibers; EOR: eugnathic occlusion complete denture with fibers; POR: progenic occlusion complete denture with fibers), followed by a letter indicating the method of treating the lower surface of the acrylic teeth (a, b, c, and d - explained in the preceding paragraph). In a clear format, it appears as follows: central incisors - 11a, 21b, 31c, 41d; first premolars - 14a, 24b, 34c, 44d, and first molars - 16a, 26b, 36c, 46d.

Statistical analysis

The results of the fracture strength measurements of complete dentures with and without reinforcement of the base subjected to compressive loading in eugnathic and progenic occlusal relationships were presented using descriptive statistics. One-way analysis of variance (ANOVA) was employed to examine the influence of base reinforcement and different surface treatment methods of the acrylic teeth on the bond strength of the interface at a significance level of $p < 0.01$. Post-hoc statistical analysis was used to investigate whether there was an interaction effect between the tested variables.

je pregleda pod svjetlosnim mikroskopom uzorci/presjeci bili su ispolirani.

Mjerenjem veličine pukotine na spoju akrilatne baze i akrilatnih zuba svjetlosnim mikroskopom, kod potpunih proteza s pojačanjem baze (karbonska vlakna) ili bez njega, željelo se testirati utječu li na snagu veze toga spoja (veličinu pukotine spoja) različiti načini pripreme površine akrilatnih zuba (bez obrade, mehanička obrada, kemijska obrada, i mehaničko-kemijska obrada). Opisi pet mjernih točaka na pukotini akrilatne baze i akrilatnih zuba jesu (slika 4.): V-rub, debljina pukotine i deformacije mjerena na rubu spoja – mjerna točka 1; V-prijelaz: mjesto prelaska horizontalnoga dijela u vertikalni – mjerna točka 2; V-sredina: mjerenje horizontalne pukotine i deformacije u sredini pukotine – mjerna točka 3;V-maks.: maksimalna izmjerena debljina pukotine i deformacija – mjerna točka 4; V-min.: minimalna debljina pukotine i deformacije – mjerna točka 5.

Veličina pukotine izmjerena je svjetlosnim inverznim mikroskopom KEYENCE VHX-7000 (Keyence International, Mechelen, Belgija) na odabranim zubima pojedinačnog kvadranta. Svaka površina promatrala se pod povećanjem od 70 puta.

Način obrade donje površine akrilatnih zuba koji u postupku tlačno-toplinske polimerizacije dolazi u kontakt s akrilatnom bazom bili su: a – bez obrade akrilatnoga zuba: b – mehanička obrada (hrapavljenje); c – kemijska obrada (premazivanje monomerom) i d – mehanička i kemijska obrada (hrapavljenje i premazivanje monomerom donje površine akrilatnih zuba).

Akrilatni zubi označeni su brojem koji označava položaj zuba u potpunoj protezi s pojačanjem (V – vlakna) ili bez (BV – bez vlakana) pojačanja (karbonska vlakana) koje su tlačno opterećivane u eugnatom (EO) i progenom okluzijskom (PO) odnosu do loma proteza (EOBV: eugnata okluzija potpuna proteza bez vlakana; POBV: progena okluzija potpuna proteza bez vlakana; EOV: eugnata okluzija potpuna proteza s karbonskim vlaknima; POV: - progena okluzija potpuna proteza s vlaknima) te slovom koje je označavalo način obrade donje površine akrilatnih zuba (a, b, c i d – gornji odlomak objašnjenje malih slova). Napisano pregledno to izgleda ovako: središnji sjekutići – 11a, 21b, 31c, 41d; prvi pretkutnjaci – 14a, 24b, 34c, 44d; prvi kutnjaci – 16a, 26b, 36c, 46d.

Statistička analiza

Rezultati mjerenja otpornosti na lom potpunih proteza s pojačanjem i bez pojačanja baza, tlačno opterećivanih u eugnatom i progenom okluzijskom odnosu, prikazani su putem deskriptivne statistike. Jednofaktorska analiza varijance koristila se za ispitivanje utjecaja pojačanja baze potpune proteze i različitih načina obrade površine akrilatnih zuba na snagu veze na razini statističke značajnosti od $p < 0,01$. Korištena je post hoc statistička analiza za ispitivanje postoji li efekt interakcije između testiranih varijabli.

Results

Based on stereo-optic measurements in the universal testing machine, the initial and maximum compressive force, i.e., the resistance to fracture at which the complete dentures fractured, were measured (Table 1). When the complete dentures were loaded in a eugnathic occlusion, fractures mostly occurred between two acrylic teeth, whereas dentures loaded in a progenic occlusion mostly fractured along the longitudinal axes of the acrylic teeth. In no case did the separation of the acrylic teeth from the acrylic base of the complete dentures occur, which is justified considering that the complete dentures were subjected to controlled conditions of constant loading.

Rezultati

Na temelju stereo-optičkih mjerenja u univerzalnom uređaju izmjerene su početna i maksimalna tlačna sila, odnosno otpornost na lom pri pucanju potpunih proteza (tablica 1.). Pri opterećivanju potpunih proteza u eugnatom okluzijskom odnosu lomovi su se događali između dvaju akrilatnih zuba, a potpune proteze opterećivane u progenom okluzijskom odnosu pucale su najčešće po uzdužnim osovinama akrilatnih zuba. Ni u jednom slučaju nije se dogodilo odvajanje akrilatnoga zuba od akrilatne baze potpunih proteza, što je opravdano s obzirom na to da su potpune proteze opterećivane u kontroliranim uvjetima konstantnog pomaka.

Table 1 Measured initial values of forces at the onset of gap initiation and maximum measured fracture forces, as well as the difference in displacement at the fracture site (gap propagation in millimeters).
Tablica 1. Izmjerene početne vrijednosti sila na početke nastanka pukotine loma i maksimalne izmjerene sile loma te razlika u pomaku na mjestu loma (širenje pukotine loma u milimetrima)

	F_{ini}, kN	F_{max}, kN	Displacement, mm
Complete dentures without fibers tested in a eugnathic occlusal relationship (Pair 1). • Potpune proteze bez vlakana testirane u eugnatom okluzijskom odnosu (par 1)	6,38	15,124	0,6
Complete dentures reinforced with carbon fibers tested in a eugnathic occlusal relationship (Pair 2). • Potpune proteze pojačane karbonskim vlaknima testirane u eugnatom okluzijskom odnosu (par 2)	9,79	19,975	1,05
Complete dentures without fibers tested in a progenic occlusal relationship (Pair 3) • Potpune proteza bez vlakana testirane u progenom okluzijskom odnosu (par 3)	6,85	15,089	0,4
Complete dentures reinforced with carbon fibers tested in a progenic occlusal relationship (Pair 4). • Potpune proteze pojačane karbonskim vlaknima testirane u progenom okluzijskom odnosu (par 4)	8,81	17,429	0,8

F_{ini} – initial fracture force • početna sila loma; F_{maks} – maximal fracture force • maksimalna sila loma; kN – kilo Newton; mm – millimeter • milimetar.

Table 2 Results of measuring gap size with a light microscope at the interface of the acrylic teeth and base for the EOO sample (complete dentures without base reinforcement subjected to compressive loading in the eugnathic occlusal relationship).
Tablica 2. Rezultati mjerenja veličine pukotine svjetlosnim mikroskopom na spoju akrilatni zubi i baza za EOBV uzorak (potpune proteze bez pojačanja baze tlačno opterećivane u eugnatom okluzijskom odnosu)

Sample EOO • Uzorak EOBV	Measurement points on the gap between the acrylic base and acrylic teeth • Mjerne točke na pukotini između akrilatne baze i akrilatnih zuba				
Method of preparation the lower surface of the acrylic teeth • Način obrade donje površine akrilatnih zuba (a, b, c, d)	V-edge • V-rub (μm)	V-transition • V-prijelaz (μm)	V- middle • V- sredina (μm)	V-max. (μm)	V-min. (μm)
11a	92	80	119	119	81
21b	96	87	110	124	83
31c	98	83	114	131	76
41d	90	92	116	127	83
14a	101	82	112	120	81
24b	97	83	108	108	84
34c	95	95	109	112	85
44d	112	91	135	144	92
16a	101	92	111	122	91
26b	91	91	102	115	91
36c	108	94	125	119	88
46d	98	82	107	109	74

Sample EOO – Complete denture without reinforcement subjected to compressive loading in eugnathic occlusion; 11,21,31,41 – central incisors; 14,24,34,44 – first premolars; 16,26,36,46 – first molars; **a** – no treatment upper right; **b** – mechanical treatment upper left; **c** – chemical treatment lower left; i **d** – mechanical-chemical treatment lower right. • Uzorak EOBV – potpuna proteza bez pojačanja tlačno opterećivana u eugnatom odnosu; 11, 21, 31, 41 – središnji sjekutići; 14, 24, 34, 44 – prvi pretkutnjaci; 16, 26 ,36, 46 – prvi kutnjaci; a – tvornički zubi, bez obrade gore desno; b – mehanička obrada (hrapavljenje) gore lijevo; c – kemijska obrada (premazivanje monomerom) dolje lijevo; i d – mehaničko-kemijska obrada (hrapavljenje i premazivanje monomerom donje površine akrilatnog zuba) dolje desno

Microscopic analysis of gap size at the interface of acrylic teeth and denture base

Tables 2 – 5 show the results (descriptive statistics) of gap size measurements at the interface of acrylic teeth and

Mikroskopska analiza veličine pukotine na spoju akrilatnih zuba i baza proteze

U tablicama od 2. do 5. rezultati su mjerenja (deskriptivna statistika) veličine pukotine na spoju akrilatnih zuba i ba-

Table 3 Results of measuring gap size with a light microscope at the interface of the acrylic teeth and base for the POO sample (complete dentures without base reinforcement subjected to compressive loading in the progenic occlusal relationship).
Tablica 3. Rezultati mjerenja veličine pukotine svjetlosnim mikroskopom na spoju akrilatni zub i baza za POBV uzorak (potpune proteze bez pojačanja baze tlačno opterećivane u progenom okluzijskom odnosu)

Sample POO • Uzorak POBV	Measurement points on the gap between the acrylic base and acrylic teeth • Mjerne točke na pukotini između akrilatne baze i akrilatnih zuba				
Method of preparation the lower surface of the acrylic teeth • Način obrade donje površine akrilatnih zuba (a, b, c, d)	V-edge • V-rub (µm)	V-transition • V-prijelaz (µm)	V- middle • V- sredina (µm)	V-max. (µm)	V-min. (µm)
11a	82	65	102	129	61
21b	85	68	97	120	59
31c	85	72	103	125	69
41d	91	75	101	122	80
14a	84	71	104	122	62
24b	88	83	94	118	71
34c	87	74	95	112	67
44d	85	70	94	121	77
16a	80	64	102	137	60
26b	81	74	92	112	66
36c	96	77	94	114	65
46d	77	59	87	109	55

Sample POO – Complete denture without reinforcement subjected to compressive loading in progenic occlusion; 11,21,31,41 – central incisors; 14,24,34,44 – first premolars; 16,26,36,46 – first molars; a – no treatment upper right; b – mechanical treatment upper left; c – chemical treatment lower left; i d – mechanical-chemical treatment lower right. • Uzorak POBV – potpuna proteza bez pojačanja tlačno opterećivana u progenom odnosu; 11,21,31,41 – središnji sjekutići; 14,24,34,44 – prvi pretkutnjaci; 16,26,36,46 – prvi kutnjaci; a – tvornički zubi, bez obrade gore desno; b – mehanička obrada (hrapavljenje) gore lijevo; c – kemijska obrada (premazivanje monomerom) dolje lijevo; i d – mehaničko-kemijska obrada (hrapavljenje i premazivanje monomerom donje površine akrilatnog zuba) dolje desno

Table 4 Results of measuring gap size with a light microscope at the interface of the acrylic teeth and base for the EOR sample (complete dentures with base reinforcement subjected to compressive loading in the eugnathic occlusal relationship).
Tablica 4. Rezultati mjerenja veličine pukotine svjetlosnim mikroskopom na spoju akrilatni zubi i baza za EOV uzorak (potpune proteze s pojačanjem baze tlačno opterećivane u eugnatom okluzijskom odnosu)

Sample EOR • Uzorak EOV	Measurement points on the gap between the acrylic base and acrylic teeth • Mjerne točke na pukotini između akrilatne baze i akrilatnih zuba				
Method of preparation the lower surface of the acrylic teeth • Način obrade donje površine akrilatnih zuba (a, b, c, d)	V-edge • V-rub (µm)	V-transition • V-prijelaz (µm)	V- middle • V- sredina (µm)	V-max. (µm)	V-min. (µm)
11a	83	66	108	119	59
21b	84	62	99	106	61
31c	85	69	103	121	63
41d	90	68	108	117	64
14a	85	62	106	111	67
24b	81	65	102	117	62
34c	82	66	97	107	64
44d	86	63	105	122	65
16a	82	64	102	117	65
26b	88	67	99	104	59
36c	91	65	96	113	63
46d	75	60	87	93	59

Sample EOR – Complete denture with reinforcement subjected to compressive loading in eugnatic occlusion; 11,21,31,41 – central incisors; 14,24,34,44 – first premolars; 16,26,36,46 – first molars; a – no treatment upper right; b – mechanical treatment upper left; c – chemical treatment lower left; i d – mechanical-chemical treatment lower right. • Uzorak EOV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u eugnatom odnosu; 11,21,31,41 – središnji sjekutići; 14,24,34,44 – prvi pretkutnjaci; 16,26,36,46 – prvi kutnjaci; a – tvornički zubi, bez obrade gore desno; b – mehanička obrada (hrapavljenje) gore lijevo; c – kemijska obrada (premazivanje monomerom) dolje lijevo; i d – mehaničko-kemijska obrada (hrapavljenje i premazivanje monomerom donje površine akrilatnog zuba) dolje desno

Table 5 Results of measuring gap size with a light microscope at the interface of the acrylic teeth and base for the POR sample (complete dentures with base reinforcement subjected to compressive loading in the progenic occlusal relationship).
Tablica 5. Rezultati mjerenja veličine pukotine svjetlosnim mikroskopom na spoju akrilatni zubi i baza za POV uzorak (potpune proteze s pojačanjem baze tlačno opterećivane u progenom okluzijskom odnosu)

Sample POR • Uzorak POV	Measurement points on the gap between the acrylic base and acrylic teeth • Mjerne točke na pukotini između akrilatne baze i akrilatnih zuba				
Method of preparation the lower surface of the acrylic teeth • Način obrade donje površine akrilatnih zuba (a, b, c, d)	V-edge • V-rub (μm)	V-transition • V-prijelaz (μm)	V- middle • V- sredina (μm)	V-max. (μm)	V-min. (μm)
11a	82	52	91	95	47
21b	72	51	86	97	44
31c	77	49	90	96	41
41d	70	51	83	85	45
14a	69	54	84	100	45
24b	71	44	87	95	42
34c	65	48	83	87	40
44d	58	46	61	69	40
16a	70	50	84	96	46
26b	59	45	71	84	45
36c	69	44	85	91	41
46d	55	42	55	66	42

Sample POR – Complete denture with reinforcement subjected to compressive loading in progenic occlusion; 11,21,31,41 – central incisors; 14,24,34,44 – first premolars; 16,26,36,46 – first molars; a – no treatment upper right; b – mechanical treatment upper left; c – chemical treatment lower left; i d – mechanical-chemical treatment lower right. • Uzorak POV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u progenom odnosu; 11,21,31,41 – središnji sjekutići; 14,24,34,44 – prvi pretkutnjaci; 16,26,36,46 – prvi kutnjaci; a – tvornički zubi, bez obrade gore desno; b – mehanička obrada (hrapavljenje) gore lijevo; c – kemijska obrada (premazivanje monomerom) dolje lijevo; i d – mehaničko-kemijska obrada (hrapavljenje i premazivanje monomerom donje površine akrilatnog zuba) dolje desno

denture base at five selected measurement points on central incisors, first premolars, and first molars considering different surface treatments of acrylic teeth and reinforcement of the denture base (carbon fibers). Compressive loading of the complete dentures until the point of fracture was conducted in eugnathic and progenic occlusal relationships of the upper and lower acrylic teeth (maximal intercuspidation and edge-to-edge occlusion).

The impact of acrylic teeth surface treatment methods and denture base reinforcement on gap size at five selected measurement points (V-edge; V-transition; V-middle; V-max; and V-min) at the interface of acrylic teeth and denture base was assessed using Welch's one-way analysis of variance. The results of the statistical analysis are presented in Tables 6 to 10. For all selected measurement points (V-edge; V-transition; V-middle; V-max; and V-min) at the interface of acrylic teeth and denture base, a statistically significant difference (P ≤ 0.001) was calculated between the means of the tested samples. The gap size at the interface of acrylic teeth (at all measurement points) and denture base decreased with the degree of mechanical-chemical pretreatment of the acrylic teeth surface, but not with the reinforcement of the base with carbon fibers.

za proteze na pet odabranih mjernih točaka kod središnjih sjekutića, prvih pretkutnjaka i prvih kutnjaka s obzirom na različite načine obrade donje površine akrilatnih zuba i pojačanje baze proteze (karbonska vlakna). Tlačno opterećivanje potpunih proteza do točke loma provedeno je u eugnatom i progenom okluzijskom odnosu gornjih i donjih akrilatnih zuba (zubni položaj maksimalne interkuspidacije i bridni tete-a-tete).

Statističkom Welchovom jednofaktorskom analizom varijance ispitivan je utjecaj načina obrade akrilatnoga zuba i pojačanja baze proteze na veličinu pukotine u pet odabranih mjernih točaka (V-rub, V-prijelaz, V-sredina; V-maks. i V-min.) na spoju akrilatnih zuba i baza. Rezultati statističke analize nalaze se u tablicama od 6. do 10. Za sve odabrane mjerne točke (V-rub, V-prijelaz, V-sredina, V-maks., i V-min.) na spoju akrilatnih zuba i baza proteze izračunata je statistički značajna razlika (P ≤ 0,001) između aritmetičkih sredina ispitivanih uzoraka. Veličina pukotine na spoju akrilatnih zuba (na svim mjernim točkama) i baza smanjivala se sa stupnjem mehaničko-kemijske predobrade površine akrilatnih zuba, ali ne i pojačanjem baze karbonskim vlaknima.

Discussion

Understanding the fracture strength of complete acrylic dentures is crucial for clinical dentists involved in the design, fabrication, and clinical practice of dentures. It enables them to make informed decisions regarding material selection, treatment planning, and patient care, ultimately resulting in

Rasprava

Razumijevanje otpornosti na lom potpunih akrilatnih proteza ključno je za stomatologe kliničare koji su uključeni u dizajn, izradu i kliničku praksu proteza. To im omogućuje da informirano odlučuju o odabiru materijala, o planiranju tretmana i skrbi za pacijente, što na kraju rezultira boljim

Table 6 Statistical analysis of the influence of gap size on the strength of the bond at the interface of acrylic teeth and acrylic base, considering the method of preparation of the lower surface of the acrylic teeth and base reinforcement, for the measurement point V-edge.

Tablica 6. Statistička analiza utjecaja veličine pukotine na snagu veze u spoju akrilatni zubi – akrilatna baza s obzirom na način pripreme donje površine akrilatnih zuba i pojačanje baze za mjernu točku V-rub

	N	Arithmetic Mean • Aritmetička sredina x (µm)	Standard Deviation • Standardna devijacija s	Homogeneity of Variance Test • Test homogenosti varijanci F	P	Test of Mean Differences • Test razlika aritmetičkih sredina F	P
Sample EOO-a • Uzorak EOBV-a	12	98.25	6.488	1.480	0.195	68.110	0.000
Sample POO-b • Uzorak POBV-b	12	85.083	4.625				
Sample EOR-c • Uzorak EOV-c	12	84.583	3.875				
Sample POR-d • Uzorak POV-d	12	68.083	8.105				

Sample EOO – Complete denture without reinforcement subjected to compressive loading in eugnatic occlusion; Sample POO – Complete denture without reinforcement subjected to compressive loading in progenic occlusion; Sample EOR – Complete denture with reinforcement subjected to compressive loading in eugnatic occlusion; Sample POR – Complete denture with reinforcement subjected to compressive loading in progenic occlusion; **a** – no treatment upper right; **b** – mechanical treatment upper left; **c** – chemical treatment lower left; i **d** – mechanical-chemical treatment lower right. • Uzorak EOBV – potpuna proteza bez pojačanja tlačno opterećivana u eugnatom odnosu; Uzorak POBV – potpuna proteza bez pojačanja tlačno opterećivana u progenom odnosu; Uzorak EOV – potpuna proteza s pojačanjem tlačno opterećivana u eugnatom odnosu; Uzorak POV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u progenom odnosu; **a** – bez obrade gore desno; **b** – mehanička obrada gore lijevo; **c** – kemijska obrada dolje lijevo; i **d** – mehaničko-kemijska obrada dolje desno

Table 7 Statistical analysis of the influence of gap size on the strength of the bond at the interface of acrylic teeth and acrylic base, considering the method of preparation of the lower surface of the acrylic teeth and base reinforcement, for the measurement point V- transition.

Tablica 7. Statistički analiza utjecaja veličine pukotine na snagu veze u spoju akrilatni zubi – akrilatna baza s obzirom na način pripreme donje površine akrilatnih zuba i pojačanje baze za mjernu točku V-prijelaz

	N	Arithmetic Mean • Aritmetička sredina x (µm)	Standard Deviation • Standardna devijacija s	Homogeneity of Variance Test • Test homogenosti varijanci F	P	Test of Mean Differences • Test razlika aritmetičkih sredina F	P
Sample EOO-a • Uzorak EOBV-a	12	87.666	6.375	0.084	0.878	64.679	0.000
Sample POO-b • Uzorak POBV-b	12	71.002	7.288				
Sample EOR-c • Uzorak EOV-c	12	64.752	6.621				
Sample POR-d • Uzorak POV-d	12	48.652	6.432				

Sample EOO – Complete denture without reinforcement subjected to compressive loading in eugnatic occlusion; Sample POO – Complete denture without reinforcement subjected to compressive loading in progenic occlusion; Sample EOR – Complete denture with reinforcement subjected to compressive loading in eugnatic occlusion; Sample POR – Complete denture with reinforcement subjected to compressive loading in progenic occlusion; **a** – no treatment upper right; **b** – mechanical treatment upper left; **c** – chemical treatment lower left; i **d** – mechanical-chemical treatment lower right. • Uzorak EOBV – potpuna proteza bez pojačanja tlačno opterećivana u eugnatom odnosu; Uzorak POBV – potpuna proteza bez pojačanja tlačno opterećivana u progenom odnosu; Uzorak EOV – potpuna proteza s pojačanjem tlačno opterećivana u eugnatom odnosu; Uzorak POV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u progenom odnosu; **a** – bez obrade gore desno; **b** – mehanička obrada gore lijevo; **c** – kemijska obrada dolje lijevo; i **d** – mehaničko-kemijska obrada dolje desno

better treatment outcomes and patient satisfaction. Fracture strength of complete acrylic dentures refers to their ability to resist fracture when exposed to external forces or loads. This property is a common clinical problem for ensuring the durability and longevity of the denture in clinical use. Factors that can affect the fracture strength of complete acrylic dentures include the quality of materials used, fabrication techniques, denture design, and additional reinforcements added to improve mechanical properties.

In this study, complete dentures were tested without reinforcement of the base and with reinforcement (carbon fiber mesh) under compressive loading in different occlusal relationships of acrylic teeth (maximum intercuspidation and tete-a-tete), simulating dental contacts occurring during masticatory function. The results of this study showed that complete denture reinforced with a carbon fiber mesh re-

ishodima liječenja i zadovoljstvom pacijenata. Otpornost na lom potpune akrilatne proteze odnosi se na njezino svojstvo da se odupire lomu kada je izložena vanjskim silama ili opterećenjima. To je ključno za osiguravanje trajnosti i dugovječnosti proteze tijekom normalne uporabe. Čimbenici koji mogu utjecati na otpornost na lom potpune akrilatne proteze uključuju kvalitetu korištenih materijala, tehniku izrade, dizajn proteze i dodatna ojačanja dodana radi poboljšanja mehaničkih svojstava.

U ovom istraživanju testirane su potpune proteze bez pojačanja baze i s pojačanjem baze (karbonska vlakna u obliku mrežice) tlačno opterećivane u različitim okluzijskim odnosima akrilatnih zuba (maksimalna interkuspidacija i tete-a-tete) simulirajući zubne kontakte koji se događaju tijekom funkcije žvačnog organa. Mjerenja su pokazala da je za potpune proteze koje su imale pojačanje baze u obliku mrežice

Table 8 Statistical analysis of the influence of gap size on the strength of the bond at the interface of acrylic teeth and acrylic base, considering the method of preparation of the lower surface of the acrylic teeth and base reinforcement, for the measurement point V- middle.

Tablica 8. Statistički analiza utjecaja veličine pukotine na snagu veze u spoju akrilatni zubi – akrilatna baza s obzirom na način pripreme donje površine akrilatnih zuba i pojačanje baze za mjernu točku V-sredina

	N	Arithmetic Mean • Aritmetička sredina x (μm)	Standard Deviation • Standardna devijacija s	Homogeneity of Variance Test • Test homogenosti varijanci F	P	Test of Mean Differences • Test razlika aritmetičkih sredina F	P
Sample EOO-a • Uzorak EOBV-a	12	114.000	9.711	2.798	0.042	18.937	0.000
Sample POO-b • Uzorak POBV-b	12	97.083	4.542				
Sample EOR-c • Uzorak EOV-c	12	101.000	5.037				
Sample POR-d • Uzorak POV-d	12	80.000	11.052				

Sample EOO – Complete denture without reinforcement subjected to compressive loading in eugnatic occlusion; Sample POO – Complete denture without reinforcement subjected to compressive loading in progenic occlusion; Sample EOR – Complete denture with reinforcement subjected to compressive loading in eugnatic occlusion; Sample POR – Complete denture with reinforcement subjected to compressive loading in progenic occlusion; **a** – no treatment upper right; **b** – mechanical treatment upper left; **c** – chemical treatment lower left; i **d** – mechanical-chemical treatment lower right. • Uzorak EOBV – potpuna proteza bez pojačanja tlačno opterećivana u eugnatom odnosu; Uzorak POBV – potpuna proteza bez pojačanja tlačno opterećivana u progenom odnosu; Uzorak EOV – potpuna proteza s pojačanjem tlačno opterećivana u eugnatom odnosu; Uzorak POV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u progenom odnosu; **a** – bez obrade gore desno; **b** – mehanička obrada gore lijevo; **c** – kemijska obrada dolje lijevo; i **d** – mehaničko-kemijska obrada dolje desno

Table 9 Statistical analysis of the influence of gap size on the strength of the bond at the interface of acrylic teeth and acrylic base, considering the method of preparation of the lower surface of the acrylic teeth and base reinforcement, for the measurement point V- max.

Tablica 9. Statistički analiza utjecaja veličine pukotine na snagu veze u spoju akrilatni zubi – akrilatna baza s obzirom na način pripreme donje površine akrilatnih zuba i pojačanje baze za mjernu točku V-maks.

	N	Arithmetic Mean • Aritmetička sredina x (μm)	Standard Deviation • Standardna devijacija s	Homogeneity of Variance Test • Test homogenosti varijanci F	P	Test of Mean Differences • Test razlika aritmetičkih sredina F	P
Sample EOO-a • Uzorak EOBV-a	12	120.833	10.526	0.512	0.602	28.510	0.000
Sample POO-b • Uzorak POBV-b	12	117.520	7.691				
Sample EOR-c • Uzorak EOV-c	12	112.250	7.581				
Sample POR-d • Uzorak POV-d	12	88.416	12.009				

Sample EOO – Complete denture without reinforcement subjected to compressive loading in eugnatic occlusion; Sample POO – Complete denture without reinforcement subjected to compressive loading in progenic occlusion; Sample EOR – Complete denture with reinforcement subjected to compressive loading in eugnatic occlusion; Sample POR – Complete denture with reinforcement subjected to compressive loading in progenic occlusion; **a** – no treatment upper right; **b** – mechanical treatment upper left; **c** – chemical treatment lower left; i **d** – mechanical-chemical treatment lower right. • Uzorak EOBV – potpuna proteza bez pojačanja tlačno opterećivana u eugnatom odnosu; Uzorak POBV – potpuna proteza bez pojačanja tlačno opterećivana u progenom odnosu; Uzorak EOV – potpuna proteza s pojačanjem tlačno opterećivana u eugnatom odnosu; Uzorak POV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u progenom odnosu; **a** – bez obrade gore desno; **b** – mehanička obrada gore lijevo; **c** – kemijska obrada dolje lijevo; i **d** – mehaničko-kemijska obrada dolje desno

quired higher compressive loads (17.4 kN and 19.9 kN) leading to fracture compared to complete dentures without base reinforcement (15.0 kN and 15.1 kN). Different fractographic behaviors were observed during compressive loading of complete dentures with and without reinforcement in both maximum intercuspidation and tete-a-tete occlusal relationships. In maximum intercuspidation, fractures occurred between two acrylic teeth, while in tete-a-tete occlusion, fractures mostly occurred along the longitudinal axes of acrylic teeth. In no case did separation occur between the acrylic teeth and the acrylic denture base.

Based on experimental measurements, it can be concluded that the load-bearing capacity of complete dentures reinforced with carbon fibers is significantly increased in maximum intercuspidation (pair 2, Table 1) compared to all other

od karbonskih vlakana bilo potrebno veće tlačno opterećenje (17,4 kN i 19,9 kN) koje je rezultiralo pucanjem u odnosu na potpune proteze bez pojačanja baze (15,0 kN i 15,1 kN). Pri tlačnom opterećivanju potpunih proteza s pojačanjem i bez pojačanja u eugnatom i progenom okluzijskom odnosu, uočeno je različito faktografsko ponašanje. U eugnatom okluzijskom odnosu lomovi su se događali između dvaju akrilatnih zuba, a u progenom okluzijskom odnosu lom se najčešće događao po uzdužnim osovinama akrilatnih zuba. Ni u jednom slučaju nije zabilježeno odvajanje akrilatnih zuba od akrilatne baze potpunih proteza.

Na osnovi eksperimentalnih mjerenja može se zaključiti da je bitno povećana nosivost potpune proteze ojačane karbonskim vlaknima u eugnatom odnosu (par 2, tablica 1.) s obzirom na sve ostale primjere. Isto tako, kod potpune prote-

Table 10 Statistical analysis of the influence of gap size on the strength of the bond at the interface of acrylic teeth and acrylic base, considering the method of preparation of the lower surface of the acrylic teeth and base reinforcement, for the measurement point V-min.
Tablica 10. Statistički analiza utjecaja veličine pukotine na snagu veze u spoju akrilatni zubi – akrilatna baza s obzirom na način pripreme donje površine akrilatnih zuba i pojačanje baze za mjernu točku V-min.

	N	Arithmetic Mean • Aritmetička sredina x (µm)	Standard Deviation • Standardna devijacija s	Homogeneity of Variance Test • Test homogenosti varijanci		Test of Mean Differences • Test razlika aritmetičkih sredina	
				F	P	F	P
Sample EOO-a • Uzorak EOBV-a	12	84.083	4.583	4.660	0.007	137.086	0.000
Sample POO-b • Uzorak POBV-b	12	66.000	7.619				
Sample EOR-c • Uzorak EOV-c	12	62.583	2.6032				
Sample POR-d • Uzorak POV-d	12	43.166	3.274				

Sample EOO – Complete denture without reinforcement subjected to compressive loading in eugnatic occlusion; Sample POO – Complete denture without reinforcement subjected to compressive loading in progenic occlusion; Sample EOR – Complete denture with reinforcement subjected to compressive loading in eugnatic occlusion; Sample POR – Complete denture with reinforcement subjected to compressive loading in progenic occlusion; **a** – no treatment upper right; **b** – mechanical treatment upper left; **c** – chemical treatment lower left; i **d** – mechanical-chemical treatment lower right. • Uzorak EOBV – potpuna proteza bez pojačanja tlačno opterećivana u eugnatom odnosu; Uzorak POBV – potpuna proteza bez pojačanja tlačno opterećivana u progenom odnosu; Uzorak EOV – potpuna proteza s pojačanjem tlačno opterećivana u eugnatom odnosu; Uzorak POV – potpuna proteza s pojačanjem (karbonska vlakna) tlačno opterećivana u progenom odnosu; **a** – bez obrade gore desno; **b** – mehanička obrada gore lijevo; **c** – kemijska obrada dolje lijevo; i **d** – mehaničko-kemijska obrada dolje desno

cases. Likewise, the complete denture reinforced with fibers in maximum intercuspidation showed the greatest difference in displacement along the fracture line between the acrylic teeth of the upper and lower dentures. The results obtained in this study indicate that reinforced fiber complete dentures have higher load-bearing capacity and allow for greater displacement of acrylic teeth compared to other dentures, without causing gaps or separation of the acrylic teeth from the acrylic base.

There have been few scientific studies published measuring the fracture strength of complete acrylic dentures as a measure of the functional longevity of this restorative material. One reason is the lack of uniformity in study design regarding the use of complete dentures as tested samples and the methodology itself. In this study, both upper and lower complete dentures were used and subjected to compression, while most published studies predominantly focus on mechanical compression testing of upper complete acrylic dentures. These studies have reported lower fracture strength values ranging from 0.69 to 1.16 kN (20); 0.79 to 2.01 kN (21); 0.7 to 0.9 kN (22); 0.7 to 1.3 kN (23); 0.56 to 1.89 kN (24), and slightly higher values of 0.40 to 4.15 kN (20). Prombonas et al. (20) attribute the lower measured fracture strength values to methodological factors, as the testing applied stress to the complete denture at a single point with high stress concentration, leading to faster fracture, predominantly of the upper acrylic complete denture. This was not the case in our study, as the dentures were loaded along the entire length of the dental arches in maximum intercuspidation and tete-a-tete occlusal relationships. Therefore, the measured fracture strength results obtained in this study cannot be directly compared with previously published studies. Another limiting factor in this *in-vitro* study in interpreting the results is the small sample size (only four pairs) of tested complete dentures.

The null hypothesis of the study was partially rejected since the reduction in the size of the gap at the junction be-

ze ojačane vlaknima u eugnatom odnosu, izmjerena je najveća razlika između pomaka u liniji loma između akrilatnih zuba gornje i donje proteze. Dobiveni rezultati pokazuju da potpune proteze ojačane vlaknima imaju veću nosivost i dopuštaju veći pomak akrilatnih zuba od ostalih proteza, bez nastanka pukotina ili odvajanja akrilatnih zuba od akrilatne baze.

Nije objavljeno mnogo znanstvenih studija u kojima je mjerena otpornost na lom potpunih akrilatnih proteza kao mjera funkcijske dugotrajnosti toga gradivnoga materijala. Jedan od razloga jest nedostatak ujednačenosti dizajna studije kad je riječ o upotrebi potpunih proteza kao testiranih uzoraka i provedbe same metodologije. U ovoj studiji autori su primijenili i tlačili gornje i donje potpune proteze, a u objavljenim studijama prevladava mehaničko tlačno testiranje najčešće gornje potpune akrilatne proteze. U tim studijama zabilježene su niže vrijednosti otpornosti na lom u rasponu od 0,69 do 1,16 kN (20); 0,79 do 2,01 kN (21) 0,7 do 0,9 kN (22); 0,7 do 1,3 kN (23); 0,56 do 1,89 kN (24) i nešto više vrijednosti od 0,40 do 4,15 kN (20). Prombonas i suradnici (20) navode da je razlog za niže izmjerene vrijednosti otpornosti na lom metodološke prirode jer se pri testiranju primjenjivalo opterećenje potpune proteze u samo jednoj točki s visokom koncentracijom opterećenja što je rezultiralo bržim lomom uglavnom gornje akrilatne potpune proteze. U ovoj studiji to nije bio slučaj jer su proteze bile opterećene po cijeloj duljini zubnih lukova potpunih proteza u eugnatom i progenom okluzijskom odnosu. Zbog toga se izmjereni rezultati otpornosti na lom ne mogu izravno uspoređivati između ove studije i onih prije objavljenih. Drugi ograničavajući čimbenik u ovoj studiji *in vitro* u interpretaciji rezultata jest mali uzorak (samo četiri para) testiranih potpunih proteza.

Nulta hipoteza istraživanja bila je djelomično odbačena zato što je na smanjenje veličine pukotine na spoju akrilatnih zuba i baza proteze utjecao način obrade površine akrilatnih zuba, a pojačanje baze proteze karbonskim vlaknima nije imalo taj utjecaj.

tween the acrylic teeth and the denture base was influenced by the surface treatment of the acrylic teeth, while the reinforcement of the denture base with carbon fibers had no such effects.

This study is a continuation of the *in-vitro* research conducted by the authors (25), where microscopic analysis was performed on standardized samples simulating the interface between acrylic teeth and acrylic base. The analysis involved measuring the size of the gap at five selected points of the interface (Figure 4). The lower surface of the acrylic tooth was treated in various ways (untreated, mechanical treatment (surface roughening), chemical treatment (coating with liquid monomer), and a combination of mechanical and chemical treatment). The results of the research (25) showed a statistically significant difference in the strength of the bond between the acrylic tooth and base for the untreated surface of the acrylic teeth (average gap size of 103 microns) compared to mechanical-chemical treatment (average gap size of 68 microns). The authors conclude that the method of treatment significantly influences the increase in the quality of the bond and that a significantly higher compressive force is required to cause fracture at the interface between the acrylic teeth and base in the universal testing machine (Instron) (measured compressive strength for untreated surface 3200 N/mm^2, and for mechanical-chemical treatment 6000 N/mm^2).

The specificity of this study lies in the fact that the test samples of the interface between the acrylic teeth and base were extracted from complete dentures that were mechanically loaded to simulate dental contacts on the acrylic teeth in both eugnathic and progenic occlusal relationships. Two out of four complete dentures had reinforcement of the base in the form of a carbon mesh. Therefore, the prepared test samples of the interface between the acrylic teeth and base of the denture were closer to real clinical conditions in which complete acrylic dentures are used. In addition to different methods of preparing the lower surface of the acrylic teeth, the aim of the study was to investigate whether reinforcing the base with carbon fibers affects the size of the gap at the interface between the acrylic teeth and base of the denture. The average gap size for all five selected measurement points (V-edge; V-transition; V-middle; V-max; and V-min) at the interface between the acrylic teeth and base of the denture ranged from 40 to 144 micrometers (Tables 2 to 6) for complete dentures with or without base reinforcement with carbon fibers. When comparing the results of the gap size at the interface between the acrylic teeth and base of the denture in this study with the published study by the authors (25), it was observed that there were no significant deviations in the range of gap sizes. Welch's one-way analysis of variance showed a statistically significant difference ($P \le 0.001$) between the means of the tested samples, thus indicating that the mechanical-chemical treatment of the lower surface of the acrylic teeth resulted in the smallest gap sizes at the five selected measurement points compared to other surface treatment methods of the acrylic teeth. On the other hand, reinforcing the base with a carbon mesh did not further reduce the size of the gap measured by light inverse microscopy.

Ovo istraživanje nastavlja se na istraživanje *in vitro* autora (25) u kojem se na standardiziranim uzorcima koji su simulirali spoj akrilatnih zuba i akrilatne baze provodila mikroskopska analiza mjerenjem veličine pukotine spoja na pet odabranih točaka spoja (slika 4). Donja površina akrilatnoga zuba bila je obrađivana na različite načine [bez obrade, mehanička obrada (hrapavljenje površine), kemijskom obradom (premazivanje površine tekućim monomerom) te kombinacijom mehaničke i kemijske obrade]. Rezultati istraživanja (25) pokazali su statistički značajnu razliku u snazi veze na spoju akrilatnih zuba i baza za netretiranu površinu akriklatnoga zuba (prosječna veličina pukotine 103 mikrona) u usporedb i s mehaničko-kemijskom obradom (prosječna veličina pukotine 68 mikrona). Autori zaključuju da na povećanje kvalitete veze na mjerenom spoju itekako utječe način obrade i da je potrebna u prosjeku znatno veća sila tlačenja koja će u univerzalnom stroju (kidalici) prouzročiti lom na spoju akrilatnih zuba i baza (izmjerena tlačna čvrstoća kod neobrađene površine 3200 N/mm^2 , a kod mehaničko-kemijske obrade 6000 N/mm^2).

Specifičnost ovog istraživanja jest to što su se ispitni uzorci spoja presjeka akrilatnih zuba i baza izdvojili iz potpunih proteza koje su bile mehanički tlačno opterećivane, imitirajuće zubne dodire na akrilatnim zubima u eugnatim i progenim okluzijskim odnosima. Dvije od četiriju potpunih proteza imale su baze pojačane karbonskim mrežicama. Tako pripremljeni ispitni uzorci spoja akrilatnih zuba i baza proteze bliži su realnijim kliničkim uvjetima u kojima se koriste potpune akrilatne proteze. Prema tome, osim različitih načina pripreme donje površine akrilatnoga zuba, svrha istraživanja bila je ispitati utječe li pojačanje baze karbonskim vlaknima na veličinu pukotine na spoju akrilatnih zuba i baza proteze. Prosječna veličina pukotina za svih pet odabranih mjernih točaka (V-rub, V-prijelaz, V-sredina, V-maks, i V-min.) na spoju akrilatnih zuba i baza proteze bila je izmjerena u rasponu od 40 do 144 mikrometra (tablice od 2. do 6.) za potpune proteze koje su bile bez pojačanja baze ili je baza bila pojačana karbonskim vlaknima. Ako se rezultati veličine pukotine na spoju akrilatnih zuba i baza proteze iz ove studije usporede s objavljenom studijom autora (25), vidjet će se da nema velikih odstupanja u rasponu veličine pukotine. Welchovom jednofaktorskom analizom varijance izračunata je statistički značajna razlika ($P \le 0{,}001$) između aritmetičkih sredina ispitivanih uzoraka, odnosno pri mehaničko-kemijskoj obradi donje površine akrilatnih zuba izmjerene su najmanje veličine pukotine u pet odabranih mjernih točaka s obzirom na druge načine obrade površine akrilatnih zuba. S druge strane, pojačanje baze karbonskim mrežicom nije dodatno smanjilo veličinu pukotine mjerenu svjetlosnim inverzivnim mikroskopom.

U većini objavljenih znanstvenih studija *in vitro* (6, 26 – 28) prevladava mjerenje smične čvrstoće na spoju akrilatnih zuba i baza proteze kao pokazatelj snage veze tog spoja. I u tim studijama rezultati pokazuju istu tendenciju da mehaničko-kemijska obrada donje površine akrilatnoga zuba daje najkvalitetniju vezu na ispitivanom spoju. Mikroskopska analiza spoja akrilatnih zuba i baza proteze nije toliko zastupljena u metodologiji znanstvenih članaka koji se bave tom

In the majority of published scientific *in-vitro* studies (6, 26-28), the prevailing measurement is shear bond strength at the interface between the acrylic teeth and the denture base as an indicator of the strength of that bond. The results of these studies consistently show that mechanical-chemical treatment of the lower surface of the acrylic teeth provides the highest strength bond at the tested interface. Although microscopic analysis of the interface between the acrylic teeth and the denture base is not as prevalent in the methodology of scientific articles addressing this issue, the results of such analysis yield the same conclusion. Evaluating the quality of the bond at the interface between the acrylic teeth and the denture base made using conventional flasking techniques, as in this study, remains relevant even for new methods of fabricating digital acrylic complete dentures such as CAD/CAM milling and 3D-printed dentures (29). In a systematic review by Prpić et al. (30), it was concluded that new technologies for fabricating acrylic complete dentures do not currently provide better quality bonding at the mentioned interface, especially in the case of printed complete dentures. Therefore, it is expected that further research will be conducted to find the best clinical-laboratory guidelines for improving the quality of the bond at the interface between the acrylic teeth and the denture base of complete dentures.

problematikom, ali rezultati analize daju isti zaključak. Ispitivanje snage veze na spoju akrilatnih zuba i baza potpunih proteza izrađenih kao u ovoj studiji konvencionalnom tehnikom kivetiranja, ostaje aktualno i za nove metode u izradi digitalnih akrilatnih potpunih proteza poput CAD/CAM frezanih i 3D printanih proteza (29). U sustavnom pregledu Prpić i suradnici (30) zaključuju da nove tehnologije u izradi akrilatnih potpunih proteza zasad ne osiguravaju bolju kvalitetu veze na navedenome spoju, a posebno se to odnosi na printane potpune proteze. Zato se očekuju nova istraživanja kako bi se pronašle najbolje kliničko-laboratorijske smjernice za poboljšanje kvalitete veze na spoju akrilatnih zuba i baza potpune proteze.

Conclusion

The results of this study have shown that the fracture strength, as an indicator of the functional durability of complete acrylic dentures, was increased by reinforcing the denture base with carbon fibers, considering the limitations of this *in-vitro* study. Reinforcement of the acrylic base of both upper and lower dentures affected the sensitivity of the upper denture to gap initiation, occurring later in the reinforced base compared to the non-reinforced base.

On the other hand, the size of the gap at the interface between the acrylic teeth and the denture base decreased with the degree of mechanical-chemical pretreatment of the lower surface of the acrylic tooth, but not due to reinforcement of the denture base with carbon mesh.

Zaključak

Rezultati ovog istraživanja pokazali su da je otpornost na lom, kao pokazatelj funkcijske trajnosti potpune akrilatne proteze, bila povećana poslije pojačanja baze potpune proteze karbonskim vlaknima, uzimajući u obzir i ograničenja ove studije *in vitro*. Pojačanje akrilatne baze gornje i donje proteze utjecalo je na osjetljivost gornje proteze na nastanak pukotine koja je kod baze s pojačanjem nastala kasnije nego kod baze bez pojačanja.

S druge strane, veličina pukotine na spoju akrilatnih zuba i baze potpune proteze smanjivala se sa stupnjem mehaničko-kemijske predobrade donje površine akrilatnih zuba, ali ne i zbog pojačanja baze proteze karbonskom mrežicom.

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Author's contribution: **M. P.** - designing an idea for research objectives; review of scientific literature; writing an article (Introduction/Purpose of research, Material and method; Results, Discussion with conclusions); implementation of the experimental part of the research. **N. G.** - designing an idea for research objectives; implementation of the experimental part of the research; statistical analysis of research. **J. P.** - implementation of the experimental part of the research. **R. Ć.** - designing an idea for research objectives; review of scientific literature; writing an article (Introduction/Purpose of research, Material and method; Results, Discussion with conclusions - control of the entire writing process).

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Doprinos autora: **M. P.** – osmišljavanje ideje za ciljeve istraživanja, pregled znanstvene literature; pisanje članka (Uvod/Svrha istraživanja, Materijal i metoda; Rezultati, Rasprava s zaključcima), provedba eksperimentalnog dijela istraživanja; **N. G.** -– osmišljavanje ideje za ciljeve istraživanja, provedba eksperimentalnog dijela istraživanja, statistička analiza istraživanja; **J. P.** – provedba eksperimentalnog dijela istraživanja; **R. Ć.** – osmišljavanje ideje za ciljeve istraživanja, pregled znanstvene literature, pisanje članka (Uvod/Svrha istraživanja, Materijal i metoda; Rezultati, Rasprava s zaključcima – kontrola cijelog procesa pisanja)

Sažetak
Svrha istraživanja: Ispitivalo se utječe li način obrade površine akrilatnih zuba i pojačanje baze proteze (karbonska vlakna) na smanjenje koncentracije naprezanja za nastanak pukotine na spoju akrilatnih zuba i baze proteze kao mjerilo snage veze. **Materijal i metode:** U istraživanju su izdvojeni uzorci presjeka akrilatnih zuba i baza proteza dobiveni iz četiriju parova potpunih akrilatnih proteza (s pojačanjem baze proteze i bez toga pojačanja) koje su bile tlačno opterećivane u univerzalnom uređaju (kidalici) u dvama različitim okluzijskim odnosima. Izabrane su skupine akrilatnih zuba (središnji sjekutići, prvi pretkutnjaci i prvi kutnjaci) iz potpunih proteza koji su bili tretirani na različite načine (bez tretmana, mehanički, kemijski i mehaničko-kemijski). Veličina pukotine na spoju akrilatnih zuba i baze proteze mjerena je svjetlosnim inverznim mikroskopom na odabranim akrilatnim zubima pojedinačnog kvadranta. Jednofaktorska analiza varijance koristila se za ispitivanje utjecaja pojačanja baze potpune proteze i različitih načina obrade površine akrilatnih zuba na snagu veze na razini statističke značajnosti od p ≤ 0,001. **Rezultati:** Mikroskopska analiza veličine pukotine mjerene u pet odabranih točaka na spoju između akrilatnih zuba i baze potpune proteze kretala se od u rasponu od 40 do 144 mikrometra. Jednofaktorska analiza varijance pokazala je statistički značajnu razliku između aritmetičkih sredina izmjerene veličine pukotine u odnosu prema različitim načinima obrade površine akrilatnih zuba. **Zaključak:** Otpornost na lom, ili kapacitet podnošenja opterećenja potpunih proteza pojačanih karbonskim vlaknima, bila je povećana u usporedbi s potpunim protezama bez pojačanja protezne baze. Smanjenje u veličini pukotine na spoju između akrilatnih zuba i baze potpunih proteza bila je pod utjecajem mehaničko-kemijske obrade donje površine akrilatnih zuba, a pojačanje baze potpune proteze karbonskim vlaknima nije utjecalo na snagu veze.

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Adresa za dopisivanje
prof. dr. sc. Robert Čelić
Sveučilište u Zagrebu Stomatološki fakultet
Zavod za mobilnu protetiku
Gundulićeva 5, 10 000 Zagreb
celic@sfzg.hr

MeSH pojmovi: umjetni zub; baza zubne proteze; karbonsko vlakno; čvrstoća pri savijanju
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