NAUČNI RAD
SCIENTIFIC ARTICLE

MICROLEAKAGE EVALUATION OF DENTAL RESTORATIVES IN DECIDUOUS AND YOUNG PERMANENT IMMATURE TEETH

PROCENA MIKROPROPUSTLJIVOSTI KOD DENTALNIH RESTAURATIVNIH MATERIJALA KOD MLEČNIH I MLADIH STALNIH ZUBA

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Abstract

Introduction: *Microleakage can be defined as passage of bacteria, liquids, molecules or ions between the prepared tooth surface and the restorative material applied. As the ability of the material to be resistant to secondary caries and microleakage determines whether the restoration is successful or not, the purpose of this study was to determine and compare the microleakage between different types of dental restoratives, as well as between different types of teeth - deciduous and young permanent immature teeth.*
Material and methods: *The evaluation was carried out by optical microscope connected to digital camera on restorations after different storage time intervals.*
Results: *The lowest dye penetration was noticed in Fuji IX, while the other materials did not show statistically significant difference. In addition, all the materials had better occlusal than cervical margins. The comparison of the samples in regard to time intervals showed that the conditioned samples have excellent resistance to microleakage, while in unconditioned samples, this percentage was lower (75%). No significant differences were found between the primary and young permanent immature teeth.*
Conclusions: *Fuji IX showed the lowest microleakage. Dyract AP and Unifil Flow had high level of microleakage, especially in the cervical area. No differences were found between different types of teeth.*

***Key words**: fluoride, glass- ionomer cement, composite, microleakage*

Kratak sadržaj

Uvod: *Mikropropustljivost se može definisati kao pokretanje bakterija, tečnosti, molekula i jona između preparirane zubne površine i upotrebljenog restaurativnog materijala. Zbog toga što sposobnost rezistencije materijala na pojavu sekundarnog karijesa determiniše uspešnost ispune, cilj ove studije bio je određivanje i kompariranje mikropropustljivosti između različitih tipova zuba, tj. mlečnih i mladih trajnih zuba.*
Materijal i metod: *Ispitivanje je bilo izvedeno pomoću optičkog mikroskopa povezanog sa digitalnom kamerom na različitim tipovima ispuna po isteku određenih vremenskih intervala.*
Rezultati: *Najmanja penetracija boje bila je zabeležana kod Fuji-ja IX, dok drugi materijali nisu pokazali statistički signifikantnu razliku. Isto tako, kod svih materijala okluzalna ivica bila je otpornija nego cervikalna. Komparacija uzoraka po vremenskim intervalima pokazuje da kondicionirani uzorci imaju odličnu otpornost na mikropropustljivost, dok kod nekondicioniranih, ovaj procenat je niži (75%). Komparacija između mlečnih i mladih stalnih zuba ukazuje da ne postoje statistički signifikantne razlike u mikropropustljivosti kod svih testiranih uzoraka.*
Zaključci: Fuji IX je pokazao najniži stepen mikropropustljivosti. Dyract AP i Unifil Flow imali su veći stepen mikropropustljivosti, naročito u cervikalniom regionu. Nije bilo razlike među različitim tipovima zuba.

Ključne reči: fluoridi, glas- jonomer cement, kompozit, mikropropustljivost

Introduction

The interface between the tooth and the restorative material was always a sensitive area and the appearance of the adhesive dentistry is a

Uvod

Interfejs između zuba i restaurativnog materijala oduvek je bio senzitivno područje a pojava adhezivne stomatologije veliki korak u

great step forward in solving this problem[1]. One of the major disadvantages of modern adhesive restorations is their limited duration due to deficient marginal adaptation. Factors that cause failure are the harsh oral environment as temperature change, bond fatigue due to the flexion of the teeth, bacterial enzymes and the watery environment[2]**.** Good marginal adaptation of the restorative materials significantly reduces the microleakage, postoperative sensitivity and the secondary caries appearance, and consecutively the restoration duration. The presence of microcracks can increase the risk of bacterial colonization and caries appearance[3].

Restorative materials should provide longevity in the oral environment. In fact, in this complex environment the material is in contact with the saliva, liquid consisting of several different organic and inorganic constituents, together with the bacterial flora.

Microleakage can be defined as passage of bacteria, liquids, molecules or ions between the prepared tooth surface and the restorative material applied[4].

The ability of the material to be resistant to secondary caries and microleakage determines whether the restoration is successful or not. The lack of integrity in the marginal area can change the morphology of the tooth structure significantly and increase the risk of secondary caries appearance[5,6]

Composite restorations are in constant demand, but are associated with the appearance of secondary caries at the edges, as a result of microleakage, plaque retention and bacterial penetrations. This is the reason why the secondary caries due to microleakage is the most frequent indication for restoration removal, although it is hard to differentiate secondary caries from marginal discoloration[6]. The limited durability of the restoration brings some of the patients in repetitive restoration cycles, which makes the restoration bigger and the therapy applied more complex.

In order to decrease the recurrent caries due to incompletely sealed margins and microleakage, efforts were made to develop new monomers and to improve the bond strength between the resin and the tooth, including the regulation of the strength of polymerization contraction, and, at the same time, hybrid materials between the glass ionomers and composite resins were developed[7]. But, up-to-date, we cannot say that a satisfying product has been produced[5].

The purpose of this study was to determine and compare the microleakage between dif-

rešavanju ovog problema[1]. Jedan od najvećih nedostataka modernih adhezivnih restauracija je njihovo ograničeno trajanje koje proizilazi od deficitne marginalne adaptacije. Faktori koji izazivaju oštećenja su surovi uslovi u usnoj šupljini, kao sto su promena temperature, zamor veze zbog zubne fleksije, bakterijski enzimi i vodena sredina[2]**.** Dobra marginalna adaptacija restaurativnih materijala signifikantno redukuje mikropropustljivost, postoperativnu senzitivnost i pojavu sekundarnog karijesa, a samim tim i trajanje restauracije. Prisustvo mikropukotina može povećati rizik od bakterijske kolonizacije i pojave karijesa[3].

Restaurativni materijali bi trebalo da obezbede dugovečnost u oralnoj sredini. U suštini, u ovoj kompleksnoj sredini, materijal je u kontaktu sa pljuvačkom, tečnost sastavljena od različitih organskih i anorganskih konstituenata, zajedno sa bakterijskom florom.

Mikropropustljivost se može definisati kao pokretanje bakterija, tečnosti, molekula i jona između preparirane zubne površine i upotrebljenog restaurativnog materijala[4].

Sposobnost materijala da bude rezistentan na pojavu sekundarnog karijesa determiniše uspešnost ispune. Nedostatak integriteta u marginalnoj zoni može značajno promeniti morfologiju zubne strukture i povećati rizik od pojave sekundarnog karijesa[5,6].

Kompozitni ispuni su u konstantnoj potražnji, ali su asocirane sa pojavom sekundarnog karijesa na rubovima, kao rezultat mikropropustljivosti, retencije plaka i bakterijske penetracije. Ovo doprinosi tome da sekundarni karijes zbog mikropropustljivosti bude najčešći razlog za odstranjivanje ispuna, iako je teško da se sekundarni karijes vizuelno diferencira od marginalne diskoloracije[6]. Limitirana trajnost restauracije kod nekih pacijenata dovodi do repetitivnih restaurativnih ciklusa, koji čine ispun većim, a terapiju koja je upotrebljena - kompleksnijom.

Sa ciljem da se smanji rekurentni karijes zbog nekompletno zapečaćenih margina i mikrocurenje, uloženi su napori da se razvije novi monomer i poboljša snaga veze između smole i zuba, uključujući regulaciju snage polimerizacione kontrakcije; a u isto vreme, razvijeni su hibridni materijali između glas jonomera i kompozita[7]. Ipak, do dana današnjeg, ne možemo reći da je proizveden produkt koji zadovoljava sve uslove[5].

ferent types of dental restoratives, as well as between different types of teeth- i.e. deciduous and young permanent immature teeth.

Material and methods

A total of 72 teeth, of which 36 deciduous and 36 permanent were used in this investigation. Indication for extraction was the exfoliation of deciduous teeth and orthodontic reasons for young permanent teeth. After extraction, the tooth surface was cleaned, the radices cut with a diamond bur with water cooling at the level of the cemento- enamel junction, and the remnants of the pulpal tissue were discarded. Class V cavities were prepared on every tooth using diamond bur and turbine with cooling water. After the preparation, the teeth were divided in five groups, filled with five different materials, given in *Table 1*. Each of the groups, consisting of deciduous and young permanent teeth, was subdivided into two groups; the first was conditioned, and the other one was left unconditioned. In the group with the composites, all of the specimens were conditioned. The conditioning and the filling was performed according to the manufacturer's instruction, and listed in *Table 1.*

The teeth were stored in artificial saliva[8] used for dental materials testing according to the British Standards Institution, BS 7115, part 2, BSI, London, 1988. Its composition is given in *Table 2.*

The specimens used in this experiment were dried, the apical side was sealed with wax to stop the infiltration of dye, and the teeth covered with nail varnish over the whole surface except the area of 2mm around the filling. The prepared teeth were put in 2% methylene blue for 10 seconds. The short period for the dye penetration enables penetration only due to the capillary activity and prevents diffusion of the dye into the adhesive[18]. The teeth were dried and cut longitudinally with a diamond bur and a turbine with water cooling and the sections were evaluated for the depth of dye penetration.

Namely, the cut surfaces were placed on the bottom of plastic moulds (Buehler®, USA, Batch No. 20-8180) with 32 mm internal diameter. The moulds were filled with resin (Epo-Thin, Buehler®, USA, Batch No.20-8140-032) and cured in a vacuum-desiccator for 1 hour.

The curing process continued at room temperature for 24 hours. The sample preparation was finished by grinding with different sizes of carborundum grits down to 1μm diamond.

Cilj ove studije bio je određivanje i kompariranje mikropropustljivosti između različitih tipova zuba, tj. mlečnih i mladih stalnih zuba.

Materijal i metod

U ovom istraživanju su upotrebljena ukupno 72 zuba - 36 mlečnih i 36 mladih stalnih zuba. Indikacija za ekstrakciju mlečnih zuba bila je fiziološka smena, a ortodontski razlozi za mlade trajne zube. Posle vađenja, površina zuba bila je iščišćena, radiksi isečeni turbinskim borerom i vodenim hlađenjem u nivou cemento-emajlovog spojišta i ostaci pulpe odstranjeni. Kaviteti V-te klase bili su preparirani na svakom zubu. Posle preparacije, zubi su bili podeljeni u pet grupa i ispunjeni sa pet različitih materijala, navedena u *Tabeli 1.* Svaka od grupa, sastavljena od mlečnih i mladih stalnih zuba, bila je podeljena u dve podgrupe; prva je bila kondicionirana, a druga ne. U kompozitnoj grupi, svi su primerci bili kondicionirani. Kondicioniranje i punjenje bilo je izvedeno po uputstvu proizvođača, a navedenim u *Tabeli 1.*

Zubi su bili skladišteni u artificijalnoj pljuvačci[8] koja se upotrebljava za testiranje dentalnih materijala, po uputstvu British Standards Institution, BS 7115, part 2, BSI, London, 1988. Sastav je opisan u *Tabeli 2.*

Primerci upotrebljeni u eksperimentu bili su isušeni, apikalna strana zapečaćena voskom da bi stopirala infiltraciju boje i zubi su bili pokriveni lakom za nokte po celoj površini, osim u zoni od 2mm oko punjenja. Zubi su postavljeni u 2% rastvoru metilen blau-a 10 sekundi. Ovaj kratak period omogućava penetraciju samo kao rezultat kapilarne aktivnosti i prevenira difuziju boje u adhezivu[18]. Zubi su bili isušeni i presečeni longitudinalno dijamantskim borerom pomoću turbine vodenim hlađenjem, a preseci evaluirani za dubinu penetracije boje.

Naime, presečene površine su postavljene na dno plastičnih modla (Buehler®, USA, Batch No. 20-8180) sa 32 mm unutrašnjim dijametrom. Modle su bile ispunjene smolom (Epo-Thin, Buehler®, USA, Batch No.20-8140-032) i jedan sat polimerizirane u vakuum-desikatoru.

Proces polimerizacije produžen je na sobnoj temperaturi još 24 sata. Priprema primeraka je završena struganjem različitim veličinama karborundumskih šmirgli do 1μm dijamanta. Tada

Table 1. Materials used in the examinations
(non-conditioned groups are not going to be treated with the material listed with an asterisk)*

Material	Type	Conditioning	Manufacturer
Fuji IX	Conventional GIC	1.**GC Cavity Conditioner*** (application 10 sec., rinsing and soft drying)	**GC**, Japan
Fuji II LC	Resin- modified GIC	1.**GC Cavity Conditioner*** (application 10 sec.,rinsing and soft drying)	**GC**, Japan
EGIC	Conventional GIC	1. **Aldrich poli(acrylic) acid***	Experimental material
Dyract AP	Compomer	1.**37% phosphoric acid** (application15 sec. on enamel, 5 sec. on dentine, rinsing)* 2.**Prime&Bond NT(***first layer***-** application 30sec., elimination of the surplus with air blow, polimerization 10sec.; *second layer*- application, elimination of the surplus, polimerization 10sec.)	**Dentsply, DeTrey**, Konstanz, Germany
Unifil flow	Fluoride releasing composite	1.**GCUnifil Bond** (*first layer*- **self-etching primer*-** application, 20sec.**,** drying 5 sec., not rinsing; *second layer*- **bonding-** application and polimerization)	**GC**, Japan

Tabela 1. Materijali upotrebljeni u ispitivanjima
(nekondicionirane grupe nisu bile tretirane sa materijalima označenim zvezdom)*

Materijal	Tip	Kondicioniranje	Proizvođač
Fuji IX	Konvencionalni GJC	1.**GC Cavity Conditioner*** (aplikacija 10 sek., ispiranje i slabo sušenje)	**GC**, Japan
Fuji II LC	GJC modifikovan smolom	1.**GC Cavity Conditioner*** (aplikacija 10 sek., ispiranje i slabo sušenje)	**GC**, Japan
EGIC	Konvencionalni GJC	1. **Aldrich poli(acrylic) acid***	Eksperimentalni materijal
Dyract AP	Kompomer	1.**37% phosphoric acid** (aplikacija 15 sek.na gleđi, 5 sek. na dentinu, ispiranje)* 2.**Prime&Bond NT(***prvi sloj***-** aplikacija 30 sek., eliminacija viška vazdušnim mlazom, polimerizacija 10 sek.; *drugi sloj*- aplikacija, eliminacija viška, polimerizacija 10 sek.)	**Dentsply, DeTrey**, Konstanz, Germany
Unifil flow	Fluor- oslobađajući kompozit	1.**GC Unifil Bond** (*prvi sloj*- **self-etching primer*-** aplikacija, 20 sek.**,** sušenje 5 sek., ne ispirati; *drugi sloj*- **bonding-**aplikacija i polimerizacija)	**GC**, Japan

Table 2. Components of the artificial saliva / Tabela 2. Sastav artificijelne pljuvačke

components / komponente	concentration (gl^{-1}) / koncentracija(gl^{-1})
NaCl	0,50
$NaHCO_3$	4,20
$NaNO_3$	0,03
KCl	0,20

Then, the microleakage was evaluated on optical microscope with an ocular connected to a digital camera, on 4x magnification.

je mikropropustljivost bila procenjena optičkim mikroskopom povezanim digitalnom kamerom sa uvećanjem od 4x.

Results

Figure 1 shows the representative samples with different level of dye penetration into the gap between the tooth and restoration. Figure 1d is a photograph of an experimental glass ionomer cement restoration, where it is obvious that the restoration is swollen and softened, so the attempt to do this experiment was unsuccessful

Rezultati

Slika1. prikazuje reprezentativne uzroke sa različitim nivoima penetracije boje u procepu između zuba i ispuna. Slika 1d je fotografija ispuna izrađenog od eksperimentalnog glas- jonomer cementa, gde je očito da je ispun natečen i smekšan, pa je pokušaj da izvedemo ovaj eksperiment bio neuspešan, jer je došlo do

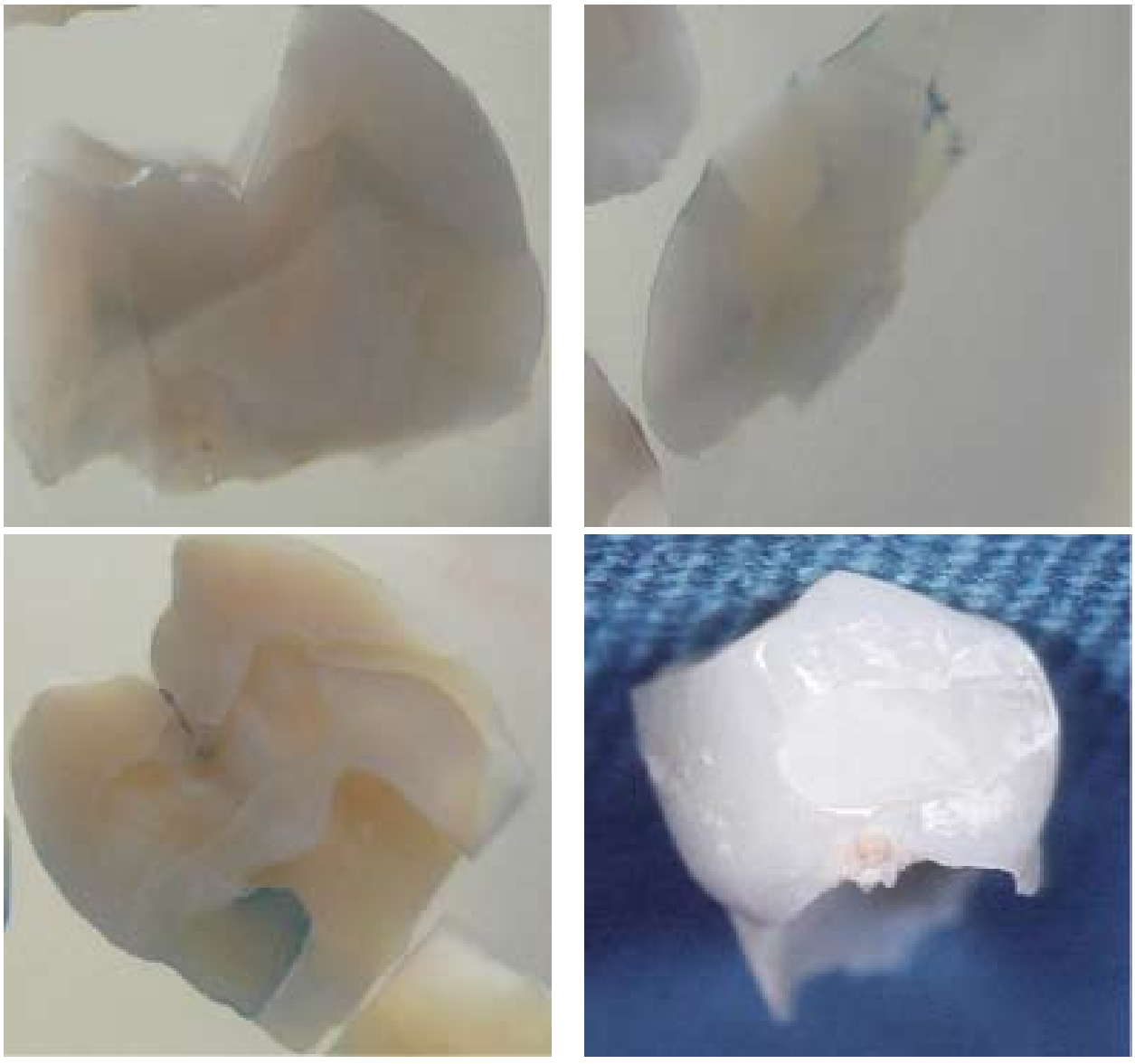


Figure 1. *Teeth prepared for evaluation of the microleakage a. 0-no microleakage; b. 1-microleakage in enamel only; c. 2-microleakege in dentin; d. experimental glass ionomer cement restoration where the determination of the microleakage was impossible*

Slika 1. *Zubi pripremljeni za evaluaciju mikropropustljivosti a. 0- nema mikropropustljivosti; b. 1- mikropropustljivost samo u gleđi; c. 2- mikropropustljivost u dentinu; d. ispun od eksperimentalnog glas jonomer cement, gde je bila nemoguća procena mikropropustljivosti*

Table 3. Values of microleakage of different materials
Tabela 3. Vrednosti mikropropustljivosti različitih materijala

		0 no leakage 0 nema pro-pustljivosti	**1 enamel 1 gleđ**	**2 dentin 2 dentin**	**t-test values t-test vrednosti**
Fuji IX	occlusal okluzalno	100% *	0	0	
	cervical cervikalno	43,75%	56,25%	0	P=0,4850
Fuji II LC	occlusal okluzalno	62,50%	37,50%	0	P=0,1676
	cervical cervikalno	6,25%*	62,50%*	31,25%	0/1 P=0,0021 0/2 P=0,0765 1/2 P=0,0821
Dyract AP	occlusal okluzalno	68,75%*	31,25%*	0	P=0,0410
	cervical okluzalno	37,50%	37,5%	25%	0,4516
Unifil Flow	occlusal okluzalno	75%*	25%*	0	P=0,0083
	cervical cervikalno	50%*	37,50%	12,5%*	0/1 P=0,4815 0/2 P=0,0293 1/2 P=0,1212
***- statistically significant values for p<0,05** *- statistički signifikantne vrednosti za p<0,05					

because there was a complete infiltration of the dye in the cement and it was impossible to determine the depth of the penetration. This is the reason why we excluded the results for the experimental glass ionomer cement in the results which we analyzed and presented.

Microleakage values for different materials are given in Table 3. Additionally, in Graph 1, the values for microleakage of separate materials on the occlusal and cervical margins were presented.

Results prove that the conventional glass ionomer cement Fuji IX shows the lowest degree of microleakage only in the cervical area. The penetration depth in this samples did not pass into dentin.

The resin-modified glass ionomer cement Fuji II LC has higher level of microleakage than the previous one. Namely, the occlusal margin behaves better than the cervical, because 62,5% are without leakage, while cervically, this percentage is significantly lower (6,25%).

kompletne infiltracije boje u cementu i bilo je nemoguće da se odredi penetracija boje. Ovo je razlog zašto smo isključili rezultate eksperimentalnog glas jonomer cementa u rezultate koje smo analizirali i prezentovali.

Vrednosti mikropropustljivosti za različite materijale prikazani su u Tabeli 3. Dopunski, Grafikon 1. pokazuje vrednosti mikrocurenja za različite materijale na okluzalnom i cervikalnom rubu.

Rezultati dokazuju da konvencionalni glas jonomer cement Fuji IX pokazuje najniži stepen mikropropustljivosti i to samo u cervikalnom regionu. Dubina penetracije ne prelazi granice dentina.

Glas jonomer cement modifikovan smolom Fuji II LC ima veći stepen mikropropustljivosti nego prethodno spomenuti. Zapravo, okluzalni rub se bolje odnosi nego cervikalni, pošto su 62,5% bez mikroprospustljivosti, dok je cervikalno ovaj procenat znatno niži (6,25%).

Dyract AP and Unifil Flow samples have better occlusal resistance to microleakage. Only 37,5% from the Dyract AP samples (50% of Unifil Flow) did not show microleakage on the cervical margin, while statistically significant number of samples (68,75% with Dyract AP and 50% with Unifil Flow) did not have microleakage on the occlusal margin.

Lowest dye penetration was noticed in Fuji IX, while other materials did not show statistically significant difference. Also, all the materials had better occlusal than cervical margin.

Comparison of the samples in regard to time intervals (Table 4) showed that the conditioned samples had excellent resistance to microleakage, while in unconditioned samples, this percentage was lower (75%). Still, statistically significant increase to following measurements existed.

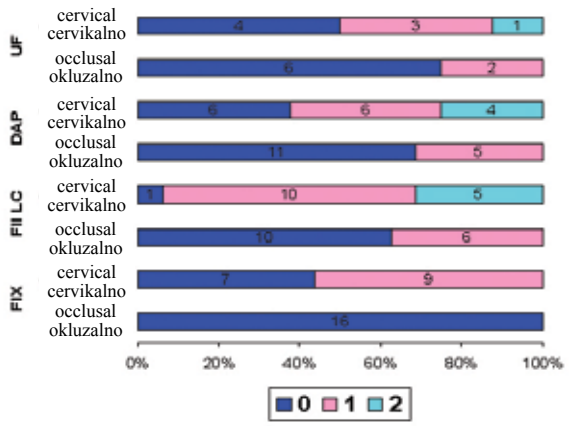
Comparison between the primary and young permanent immature teeth (Graph 2) demonstrated that there was no statistically significant difference in microleakage in the tested samples.

Discussion

The ability of the material to be resistant to the appearance of secondary caries and microleakage on restoration margins determines whether a restoration is successful or not. The lack of integrity in the marginal areas can change the morphology of the tooth structure significantly over time and increase the risk of enamel and dentin secondary caries[5,6].

Uptake of liquid and material's solubility have significant clinical influence, because the absorption of liquids may have positive and negative effects. Dimensional changes as a result of water uptake may lead to compensation of initial polymerization contraction, and this can contribute to reduction of the microleakage. Hygroscopic expansion may lead to release of internal tension caused by polymerization contraction during the setting of the resin-based materials. However, most significant stress occurs during the initial polymerization contraction (the first 30 seconds), while the water absorption persists for a few weeks. The absorbed water may act as a plasticizer, therefore weakening the material[9].

The conventional glass ionomer cement examined in our study did not present microleak-



Graph 1. *Microleakage in teeth samples restored with different materials*
Grafikon 1. *Mikropropustljivost zubnih primeraka ispunjenih različitim materijalima*

Uzorci Dyract-a AP i Unifil Flow-a imaju bolju okluzalnu otpornost prema mikropropustljivosti. Samo 37,5% uzoraka sa ispunama od Dyract AP-a (i 50% od Unifil Flow-a) nisu pokazali mikropropustljivost na cervikalnom rubu, dok statistički signifikantan broj primeraka (68,75% sa Dyract AP-om i 50% sa Unifil Flow-om) nisu imali mikropropustljivost na okluzalnoj margini.

Najmanja penetracija boje bila je zabeležana kod Fuji-ja IX, dok drugi materijali nisu pokazali statistički signifikantnu razliku. Isto tako, kod svih materijala, okluzalna ivica je bila otpornija nego cervikalna.

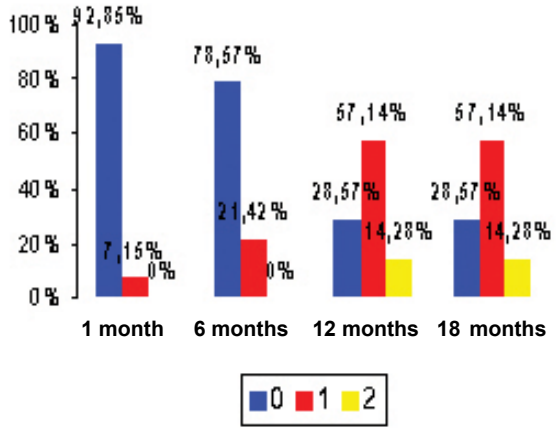
Komparacija uzoraka po vremenskim intervalima (Tabela 4.) pokazuje da kondicionirani uzorci imaju odličnu otpornost na mikropropustljivost, dok kod nekondicioniranih, ovaj procenta je niži (75%). Ipak, postoji statistički značajna razlika u svakom sledećem merenju. Komparacija između mlečnih i mladih trajnih zuba (Grafik 2.) ukazuje da ne postoje statistički signifikantne razlike u mikropropustljivosti kod svih testiranih uzoraka.

Diskusija

Sposobnost materijala da bude rezistentan na pojavu sekundarnog karijesa i mikrocurenja na rubovima ispuna određuje da li je ispun uspešan ili nije. Nedostatak integriteta u marginalnim delovima tokom vremena može značajno promeniti morfologiju zubne strukture i povećati rizik od sekundarnog karijesa gleđi i dentina[5,6].

Table 4. Comparison od microleakage between conditioned and unconditioned samples in respect to time
Tabela 4. Komparacija mikropropustljivosti između kondicioniranih i nekondicioniranih primeraka tokom vremena

		1 month 1 mesec	6 months 6 meseci	12 months 12 meseci	18 months 18 meseci	t-test
Conditioned Kondicionirani	**0**	100,00%	75,00%	33,33%	41,60%	p=0,0049
	1	/	16,70%	50,00%	58,13%	p=0,0315
	2	/	8,30%	16,70%	16,66%	p>0,05
Unconditioned Nekondicioni- rani	**0**	75,00%	50,00%	25,00%	25,00%	p=0,0136
	1	25,00%	41,70%	58,30%	50,00%	p>0,05
	2	/	8,30%	16,70%	25,00%	p>0,05



Graph 2. Comparison of microleakage in primary and young immature permanent teeth after different time intervals
Grafik 2. Komparacija mikropropustljivosti kod mlečnih i mladih stalnih zuba u različitim vremenskim intervalima

age on the edges. Namely, although a part of the restorations were dyed (because of the porosity of the glass ionomer, there was an infiltration of dye into the restoration), we did not notice presence of dye into the tooth enamel and dentin. This can be explained by the formation of zone of interaction (ion exchange layer) which is more resistant and does not permit microcracks between the glass ionomer cement and the hard dental substances.

In fact, the microleakage is a main problem of the resin-based restorations. The results that we gained in our examinations point out that highest degree of micorleakage was registered in the composite restorations. Unifil Flow is a fluoride-releasing composite resin which has fluoro-alumino-silicate glass as a source for releasing fluorides and is bonded to tooth structures with Unifil Bond. Unifil Bond is a self-etching, two-step, light-curing bonding system, which has 4-MET adhesive monomer.

Primanje tečnosti i rastvorljivost materijala imaju značajan klinički uticaj, jer apsorpcija tečnosti može imati pozitivne i negativne efekte. Dimenzionalne promene kao rezultat primanja vode mogu dovesti do kompenzacije inicijalne polimerizacione kontrakcije i ovo može kontribuirati u smanjenju mikropropustljivosti. Hidroskopna ekspanzija može dovesti do oslobađanja unutrašnje tenzije uzrokovane polimerizacionom kontrakcijom za vreme vezivanja materijala koji sadrže smolu. Ipak, najznačajniji stres postoji za vreme inicijalne polimerizacione kontrakcije (prvih 30 sekundi), dok vodena apsorpcija perzistira nekoliko nedelja. Apsorbovana voda može delovati kao plastifikator, tako što može oslabiti materijal[9].

Konvencionalni glas jonomer cement, koji smo ispitivali u ovoj studiji, nije pokazao mikropropustljivost na rubovima. Zapravo, iako je jedan deo ispuna bio prebojen (zbog poroznosti glas jonomera, došlo je do infiltracije boje u ispunu), nismo primetili prisustvo boje u zubnoj gleđi i dentinu. Ovo se može objasniti formiranjem zone interakcije (sloj jonske razmene) koja je rezistentnija i onemogućuje pojavu mikropukotina između glas jonomera i tvrdih zubnih tkiva.

U stvari, mikropropustljivost je glavni problem materijala koji sadrže smolu. Rezultate koje smo dobili u našim ispitivanjima ukazuju da je najveći stupanj mikropropustljivost registrovan kod kompozita. Unifil Flow je fluor-oslobađajući kompozit koji koristi fluoro-alumino-silikatno staklo kao izvor za fluoride i povezuje se preko zuba sa Unifil Bond-om. Unifil Bond je self-etching, dvostepeni, svetlosno polimerizirajući bonding sistem, koji sadrzi 4-MET adhezivni

The fluoride ions from Unifil Flow have potential to enter the tooth structure because of the hydrophilic monomer from the Unifil Bond. However, in our study, we came up to a conclusion that this composite has a significant level of microleakage on the edges of the restoration, especially on the cervical edge. This may be a result of the fact that the flowable composites have lower filler content, and therefore contract more intensively than the traditional composites. But, on the other side, because of the same fact, they moisturize the surface better, which gives lower modulus of elasticity. This leads to short-term reduction of marginal microleakage due to its "reduction-of-stress-by-fluidity" property, but also, long-term reduction of microleakage because of improved durability under the influence of the flexion strengths, which is most important to Class V cavities used in our investigations. Some studies that examined microleakage offer contradictory results[10,11]. Our findings are supported by the study of Ziskind et al., who found that the use of flowable composite does not reduce the microleakage[12].

Regarding the compomers, Ernst et al.[5], found that their microleakage is lower than composite resins, which confirms our results.

The microleakage at the interface between the tooth and the composite resin presents a severe problem in the deciduos dentition and is connected with recurrent caries and vital pulp inflammation[13]. According to Sumikawa et al.[14], deciduous teeth have wider dentinal tubuli, so the etching process increases the lumen additionally, and therefore, the surface available for adhesion is reduced. In this context, because of the difference in the quantity and the distribution of minerals between the deciduous and permanent teeth, the etching is more intense in deciduous teeth, which causes deeper demineralization of the intertubular dentin[15].

The presence of microchannels in these teeth, also, leads to reduction of the bond strength. That is why, in order to improve the bond, the use of low concentration acids and reduction of the etching time is suggested[13]. The microleakage that was registered in our study did not produce significant differences between the deciduous and young permanent immature teeth, probably because of wide dentinal tubules in young permanent immature teeth (just like in the deciduous teeth).

monomer. Fluoridni joni iz Unifil Flow-a imaju potencijal da uđu u zubnu strukturu zbog hidrofilnog monomera iz Unifil Bond-a. Ipak, u našoj studiji došli smo do zaključka da ovaj kompozit ima značajan stepen mikropropustljivosti na rubovima ispuna, naročito u cervikalnom delu. Ovo može biti rezultat činjenice da tečni kompoziti imaju manji stepen filler-a, pa kontrahiraju intenzivnije nego tradicionalni kompoziti. Ipak, sa druge strane, zbog te iste činjenice, oni vlažne površinu bolje, što daje manji modulus elesticiteta. Zbog toga dolazi do kratkotrajne redukcije mikrocurenja, zbog tzv. pojave "redukcije stresa zbog fluidnosti", ali i dugoročne redukcije mikrocurenja zbog bolje trajnosti pod uticajem fleksionih sila, što je najznačajnije kod kaviteta V klase, koju smo koristili u našim ispitivanjima. Neke studije koje ispituju mikropropustljivost nude kontradiktorne rezultate[10,11]. Naši nalazi su potkrepljeni studijom Ziskind et al., koji tvrde da upotreba tečnog kompozita ne redukuje mikropropustljivost[12].

Kad su u pitanju kompomeri, Ernst et al.[5], kažu da je njihov stepen mikropropustljivost niži od kompozita, što je potvrđeno i u našim rezultatima.

Mikropropustljivost na interfejsu između zuba i kompozita predstavlja ozbiljni problem u mlečnoj denticiji i povezan je sa rekurentnim karijesom i inflamacijom vitalne pulpe [13]. Sumikawa et al.[14] kaže da mlečni zubi imaju šire dentinske tubule, pa proces jetkanja ih dopunski proširuje i dovodi do redukcije površine dostupne za atheziju. U ovom kontekstu, činjenica je da zbog razlike u kvantitetu i distribuciji minerala između mlečnih i trajnih zuba, jetkanje je intenzivnije kod mlečnih zuba što dovodi do dublje demineralizacije intertubularnog dentina[15].

Prisustvo mikrokanala kod ovih zuba isto tako dovodi do redukcije sile vezivanja. Zato, sa ciljem da se veza poboljša, sugerisana je upotreba kiselina manjih koncentracija i redukcija vremena jetkanja[13]. Mikropropustljivost koja je registrovana u ovom eksperimentu nije dala signifikantne razlike između mlečnih i mladih stalnih zuba, verovatno zbog toga što kod mladih stalnih zuba (isto kao i kod mlečnih zuba) postoje široki dentinski tubuli.

Conclusions

1. Conventional glass ionomer cement Fuji IX showed the lowest microleakage.

2. The compomer Dyract Ap and the fluoride releasing composite Unifil Flow had high level of microleakage, especially in the cervical area.

3. No differences were found between different types of teeth, i.e. deciduous and young permanent immature teeth.

Zaključci

1. Konvencionalni glas jonomer cement Fuji IX pokazao je najniži stepen mikropropustljivosti.

2. Kompomer Dyract AP i fluor- oslobađajući kompozit Unifil Flow, imali su visok stepen mikropropustljivosti, naročito u predelu cervikalnog ruba.

3. Nisu pronađene razlike između različitih tipova zuba, tj. mlečnih i mladih stalnih zuba.

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