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Microleakage assessment of a resin based sealant after acid etching and Er: YAG laser treatment – an *in vitro* study

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SUMMARY

Introduction Marginal adaptation of sealants is important element in prevention of dental caries. The failure of marginal adaptation leads to marginal leakage, passage of bacteria, fluids, molecules or ions between enamel and sealant, creating possibility for development of dental caries below the sealant. The aim of this study was to assess and compare microleakage of resin based sealant after acid etching and Er: YAG laser treatment of enamel.

Materials and Methods An *in vitro* study included 30 premolars and molars extracted for orthodontic purpose, without any structural anomalies, and divided in the two groups of 15 samples. Group I included teeth with fissures sealed using resin based sealant (Helioseal-F, Ivoclar Vivadent AG, Liechtenstein) after enamel etching with 37% phosphoric acid. Group II consisted of teeth where fissures were sealed with resin based sealant (Helioseal-F, Ivoclar Vivadent AG, Liechtenstein) after enamel etching with Er: YAG laser (Fotona Light Walker Laser).

Results In the group I, 10 (66.67%) samples demonstrated level 0 microleakage, 2 (13. 33%) samples demonstrated level 1 microleakage and 3 (20%) samples demonstrated level 3 microleakage. In the second group, 10 (66.67%) samples demonstrated level 0 microleakage, 1 (6.67%) demonstrated level 1 microleakage, 2 (13.33%) samples demonstrated level 2 microleakage and 2 (13.33%) samples showed level 3 microleakage. Descriptive statistics for microleakage resulted with mean score=0.73 for the first and second group. There was no statistically significant difference in chosen technique for etching occlusal enamel (37% phosphoric acid or Er: YAG Laser radiation) $p>0,05$ ($p=0,98$), when placing fissure sealants.

Conclusion The use of Er: YAG Laser radiation for pits and fissures treatment, demonstrated excellent results and could replace the procedure of etching pits and fissures with phosphoric acid, with the same effect and without the negative impact of the phosphoric acid.

Keywords: prevention; microleakage; pit and fissure sealant

INTRODUCTION

From prevention perspective, anatomic grooves or pits and fissures on occlusal surfaces of permanent molars trap food debris and promote the presence of bacterial biofilm, thereby increasing the risk of developing carious lesions. Effectively penetrating and sealing these surfaces with dental material – for example, pit-and-fissure sealants—can prevent lesions and is part of comprehensive caries management approach [1]. The most appropriate and cost-effective treatment for the prevention of occlusal caries in children at high risk is the application of pit-and-fissure sealants [2, 3]. Retention rates vary according to the proper isolation of the working field, viscosity of the sealant material, preparation of enamel surfaces, and use of an adhesive system [4].

The use of phosphoric acid is well-accepted, standard method for roughening enamel surfaces. Unfortunately, conditions are not always optimal and organic remnants as well as fissure morphology and aprismatic enamel structure can reduce etching performance and thus compromise adhesion [5]. The use of erbium: yttrium-aluminum-garnet (Er: YAG) laser irradiation for dental applications has become increasingly widespread since FDA approval in 1997, and its use for pretreatment and surface conditioning in pit-and-fissure sealing has since been under discussion [6–9].

The laser irradiation of hard dental tissue modifies the calcium/phosphorus ratio, reduces the carbonate/phosphate ratio, and leads to the formation of more stable and less acid-soluble compounds, thus reducing susceptibility to acid attacks and caries [10, 11]. It has also been shown that it has an anti-bacterial effect by trapping free ions and forming remineralisation micro spaces [10, 12].

On the other hand several studies are attributing some level of negative impact of the conventional enamel etching due to demineralization process that occurs after acid etching. It is possible that enamel becomes more vulnerable to dental caries, especially if demineralized surface remains uncovered from the material used as dental seal-

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ant. Numerous studies have been done in order to find alternative procedures for enamel preparation such as Er: Yag Laser radiation. Operating principle of Er: Yag Laser is "mechanical" with micro-explosions of instant evaporation of the tissue water.

Retention and good adaption of the sealants with the occlusal surface of the enamel is essential for their success.

Therefore, the aim of our study was to assess and compare microleakage of resin based sealant after acid etching and Er: YAG laser treatment of enamel.

MATERIALS AND METHODS

An *in vitro* study that included 30 extracted premolars and molars free of any caries, structural anomalies, without restorations and with orthodontic indication for extraction were distributed equally in the two groups (15 in each). After the extraction the samples were stored in saline solution.

The two groups tested were:

Group-I: Fissures sealed with composite based fissure sealant (Helioseal-F, Ivoclar Vivadent AG, Liechtenstein) after enamel etching with 37% phosphoric acid.

Group-II: Fissures sealed with composite based fissure sealant (Helioseal-F, Ivoclar Vivadent AG, Liechtenstein) after enamel treatment with Er: YAG laser (Fotona Light Walker Laser).

For microleakage assessment, samples were cleaned with periodontal curettes and pumice, washed, rinced with 3% hydrogen peroxide and dried with oil free air syringe.

According to the manufacturer instructions, the samples from the first group were etched with 37% phosphoric acid gel during 30 seconds, rinsed with water, dried with oil free air syringe and sealed with resin based sealant Helioseal-F. The sealant was photopolymerized for 20 seconds with halogen lamp Bonart art-L2 with wavelength around 400 nm.

The occlusal surface of the samples from the second group was treated with laser irradiation of Fotona Light-Walker Laser (Erbium: YAG laser) with 6W intensity, energy of 300 mJ per pulse and frequency of 20 Hz. After the irradiation the samples were dried with oil free air syringe and sealed accordingly to the manufacturer instructions as the samples of the first group.

The root apices were sealed with red wax. All the samples were then covered with two layers of nail varnish, except for the 1 mm window around the sealant margins, and immersed in 2% methylene blue solution for 24 h.

After the dye exposure, the teeth were thoroughly washed under running tap water for 5 minutes to remove the superficial dye and then nail varnish was removed with the scalpel. Longitudinal sections were prepared with a diamond disk, in bucco-lingual direction. Approximately 1.5 mm thick sections were made to assess the degree of dye penetration in the occlusal cavity walls separately under a binocular microscope at 40X magnification and photographed with digital camera. Marginal dye penetration was assessed and determined 4 levels of marginal leakage (0-No penetration, 1-Penetration up to one half the sealant's length, 2-Penetration greater than one half, not including the underlying fissure, 3- Penetration into the underlying fissure) as per Overbo R.C and Raddal M [13].

Microleakage data for each groups were compared using the Kruskal-Wallis test ($p = 0.05$). Significant differences were evaluated using the Mann–Whitney U test (Z).

RESULTS

In the first group that contained samples sealed with Helioseal-F after etching enamel with 37% phosphoric acid, 10 (66.67%) samples demonstrated level-0 microleakage, 2 (13.33%) samples demonstrated level-1 microleakage and 3 (20%) samples demonstrated level-3 microleakage. Second group that contained samples, sealed with Helioseal-F, after enamel treatment with Er: YAG laser radiation showed following results: 10 (66.67%) samples showed level-0 microleakage, 1 (6.67%) sample showed level-1 microleakage, 2 (13.33%) samples demonstrated level-2 microleakage and 2 (13.33%) samples demonstrated level-3 microleakage (Table 1).

Table 1. Microleakage of the fissure and pitt sealant after etching enamel with 37% phosphoric acid and Er:YAG laser treatment.
Tabela 1. Mikrocurenje zalivača fisura nakon nagrizanja gleđi sa 37% fosfornom kiselinom i tretmana gleđi laserom Er: YAG

	N broj	Microleakage score (%) Mikrocurenje (%)			
		0	1	2	3
Group 1 Etched with 37% phosphoric acid Grupa 1, tretirana 37% fosfornom kiselinom	15	10	2	0	3
		66.67%	13.33%	0.00%	20.00%
Group 2 Treated with Er: YAG laser radiation Grupa 2, tretirana laserom Er: YAG	15	10	1	2	2
		66.67%	6.67%	13.33%	13.33%

$p > 0,05$ ($p = 0,98$) indicates that there was no statistically significant difference in microleakage between the samples from the first group (sealed with resin based sealant / etched with 37% phosphoric acid gel) and samples from the second group (sealed with resin based sealant / treated with Er: YAG laser radiation) (Figures 1–6).

DISCUSSION

International paediatric dentistry guidelines recommend sealing the primary and permanent molars in children and adolescents to prevent the onset of cavities and minimize the progression of noncavitated occlusal carious lesions [14, 15]. Pretreatment of enamel with various concentrations of phosphoric acid is traditional method that has certain disadvantages; therefore, other methods

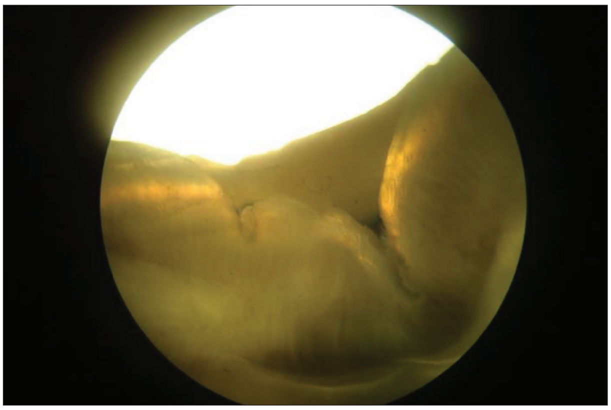

Figure 1. Level 3 microleakage
Slika 1. Treći nivo mikrocurenja

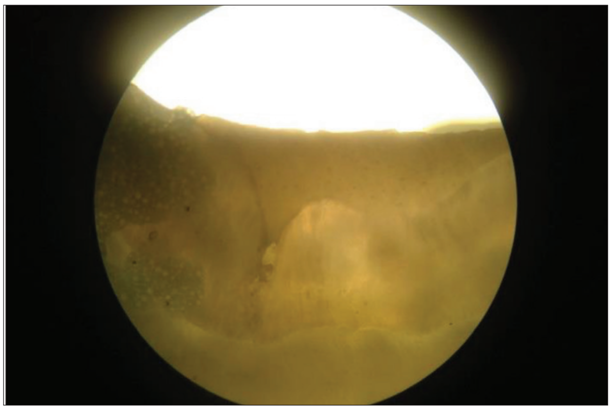

Figure 2. Level 0 microleakage
Slika 2. Nulta vrednost mikrocurenja

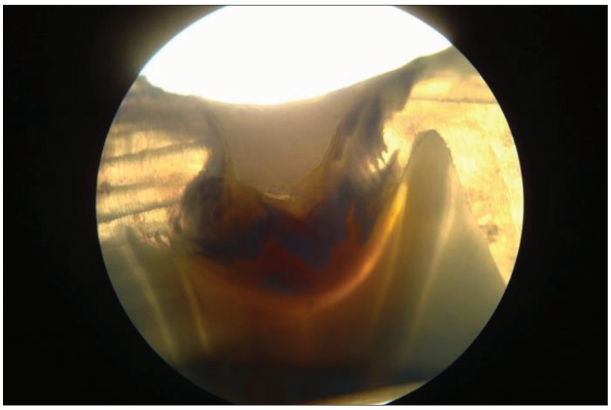

Figure 3. Level 0 microleakage
Slika 3. Nulta vrednost mikrocurenja

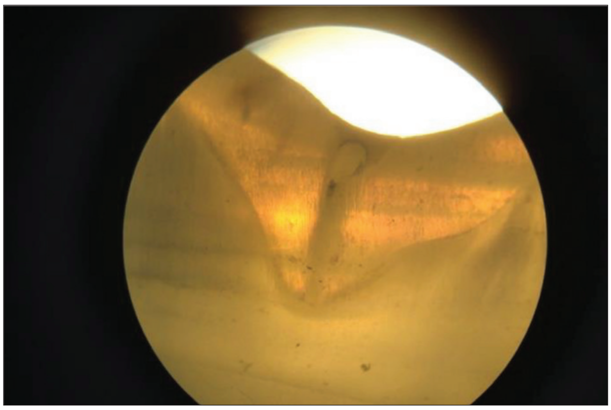

Figure 4. Level 0 microleakage
Slika 4. Nulta vrednost mikrocurenja

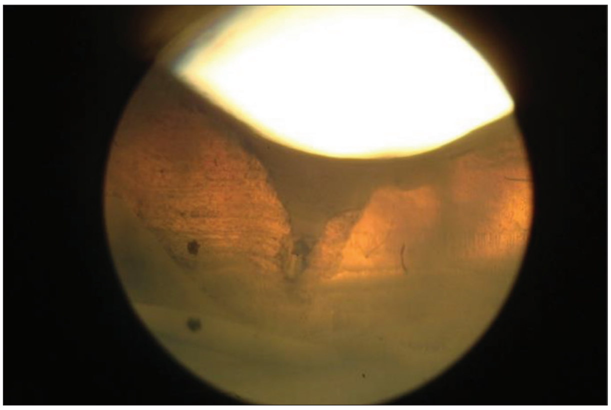

Figure 5. Level 3 microleakage
Slika 5. Treći nivo mikrocurenja

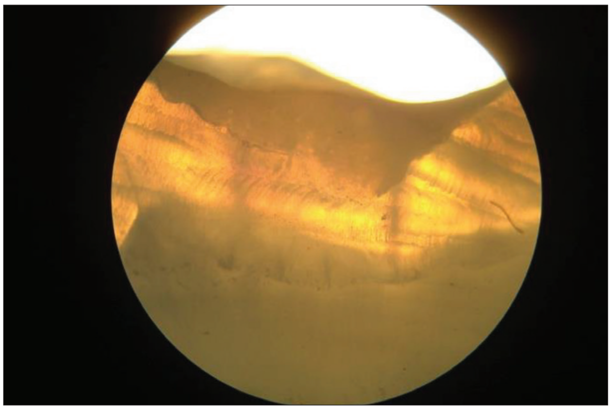

Figure 6. Level 0 microleakage
Slika 6. Nulta vrednost mikrocurenja

such as laser etching of enamel surfaces have gained popularity [9, 16].

Sealant efficiency depends on the ability to achieve strong bond with enamel on occlusal surface. This bond is greatly responsible for the level of microleakage in the interface enamel-sealant. The main reasons for sealant loss are microleakage, sealant depth penetration and placement technical skills.

Operating principle of Er: Yag Laser is "mechanical" with micro-explosions of instant evaporation of the tissue water. Occlusal enamel surface absorbs the laser energy promoting surface modifications, resulting in greater treatment achievement.

Current research has indicated that the application of laser ablation as an adjunct to traditional phosphoric acid etching may improve adhesion, adaptation, retention, and resistance to microleakage of resin-based sealants [17, 18]. Recent clinical and *in vitro* studies support the use of laser ablation prior to acid etching [17–20], although these findings are not unanimously confirmed [5, 21, 22].

Baygın et al. [6] (Er,Cr:YSGG laser 2W, 20 Hz) and Shahabi et al. [9] (Er:YAG laser 100 mJ, 10 Hz) reported that laser etching may be an alternative to conventional acid etching, but laser etching did not eliminate the need for acid etching prior to placement of fissure sealants. Hossain et al. reported that stereomicroscopic observation revealed laser completely cleaning debris in pits and fissures, reaching the narrowest, deepest parts of the fissures [23]. Authors concluded that the laser removal of debris accumulated in fissures could improve sealant retention. Our findings are in alignment with the findings of Hossain et al. [23] that the laser could improve sealant retention, and also partially in alignment with Baygın et al. [6] and Shahabi et al. [9] where they suggested that laser etching may constitute an alternative to conventional acid etching.

Several findings concerning the use of lasers for enamel etching are contradictory. Some researchers stated that laser irradiation was not capable of etching enamel. Martinez-Insua et al. found weaker adhesion forces in a Er: YAG laser-etched enamel surface than an acid-etched enamel surface [24]. This was related to sub-surface cracks observed in SEM images. Tarcin et al. found that microtensile bond strength was significantly lower in the acid-etched group than the Er, Cr: YSGG and Nd: YAG laser-etched enamel group for both bonding agents used [25]. Borsatto et al. and Lupi-Pegurier et al.. both verified that Er: YAG laser irradiation did not eliminate need to etch enamel surface with acid before applying the sealant [26, 27].

CONCLUSION

Er: YAG laser irradiation of pits and fissures could provide strong enamel-sealant adhesion and prevent microleakage and it may be recommended as an alternative method for etching pits and fissures when fissure sealants are applied.

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Procena mikropropustljivosti zalivača na bazi smole nakon nagrizanja kiselinom i tretmana laserom Er: YAG – *in vitro* studija

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KRATAK SADRŽAJ

Uvod Marginalno zaptivanje zalivača je izuzetno važan element u prevenciji zubnog karijesa. Neuspeh marginalnog zaptivanja dovodi do marginalne mikropropustljivosti, odnosno prodora bakterija, tečnosti, molekula ili jona između gleđi i zalivača, što stvara mogućnost za razvoj zubnog karijesa.

Cilj ove studije je bio da se proceni i uporedi mikropropustljivost zalivača na bazi smole nakon nagrizanja kiselinom i laserskog tretmana Er: YAG laserom.

Materijali i metode U istraživanje je bilo uključeno 30 premolara i molara ekstrahovanih iz ortodontskih razloga, bez ikakvih strukturnih anomalija, podeljenih u dve grupe – od po 15 zuba za svaku grupu. Grupa I: fisure zalivene zalivačem na bazi smole (Helioseal-F, Ivoclar Vivadent AG, Lihtenštajn), gde je nagrizanje sprovedeno 37% ortofosfornom kiselinom. Grupa II: fisure zalivene zalivačem na bazi smole (Helioseal-F, Ivoclar Vivadent AG, Lihtenštajn) nakon tretmana laserom Er: YAG (laser Fotona Lightwalker).

Rezultati Prva grupa je sadržala uzorke zalivene Helioseal-F, nagrižene 37% ortofosfornom kiselinom. Deset (66,67%) uzoraka je pokazalo mikropropustljivost ocene 0, dva (13,33%) uzorka mikropropustljivost ocene 1, a tri (20,00%) uzorka mikropropustljivost ocene 3. Druga grupa je sadržala uzorke zalivene Helioseal-F, nakon primene laserskog zračenja Er: YAG. Deset (66,67%) uzoraka je pokazalo mikropropustljivost ocene 0, jedan (6,67%) uzorak mikropropustljivost ocene 1, dva (13,33%) uzorka mikropropustljivost ocene 2 i dva (13,33%) uzorka mikropropustljivost ocene 3.

Deskriptivna statistika mikropropustljivosti rezultirala je srednjim rezultatom 0,73 za prvu i drugu grupu. Rezultati studije pokazuju da nema razlike u tehnici koju smo odabrali za nagrizanje okluzalne gleđi (37% ortofosforna kiselina ili lasersko zračenje Er: YAG): $p > 0,05$ ($p = 0,98$). Razlika nije statistički značajna između ove dve grupe.

Zaključak Upotreba laserskog zračenja Er: YAG za tretiranje jamica i fisura pokazala je odlične rezultate i mogla bi da zameni postupak nagrizanja jama i fisura ortofosfornom kiselinom, sa istim efektom i bez negativnog uticaja ortofosforne kiseline.

Ključne reči: prevencija; mikropropustljivost; zalivač jama i fisura

UVOD

Iz perspektive primarne prevencije, anatomske brazde ili jamice na okluzalnim površinama stalnih molara zadržavaju ostatke hrane i promovišu prisustvo bakterijskog biofilma, povećavajući tako rizik od nastanka karijesa. Efikasno prodiranje i zaptivanje ovih površina zubnim materijalom – na primer, zalivačima jamica i fisura – može se sprečiti pojava karijesne lezije, što predstavlja deo sveobuhvatnog pristupa lečenju karijesa [1]. Najbolji i najisplativiji tretman za prevenciju okluzalnog karijesa kod dece sa visokim rizikom je primena zalivača fisura [2, 3]. Stope opstajanja variraju u zavisnosti od pravilne izolacije radnog polja, viskoznosti materijala za zalivanje, pripreme površine gleđi i upotrebe adhezivnog sistema [4].

Upotreba ortofosforne kiseline je dobro prihvaćena, standardna metoda za grubo obrađivanje površine gleđi. Nažalost, uslovi nisu uvek optimalni i organski ostaci, kao i morfologija fisura i aprizmatična struktura gleđi, mogu smanjiti performanse nagrizanja i tako ugroziti adheziju [5]. Upotreba laserskog zračenja erbijum: aluminijum-granat (Er: YAG) u stomatološkoj praksi postala je sve učestalija od odobravanja FDA, 1997. godine, a njegova primena u pripremi i kondicioniranju površine gleđi u zalivanju jamica i fisura od tada se ispituje i proverava [6–9].

Lasersko zračenje tvrdog zubnog tkiva menja odnos kalcijum : fosfor, smanjuje odnos karbonat : fosfat i dovodi do stvaranja stabilnijih jedinjenja, manje rastvorljivih u kiselini, smanjujući tako podložnost dejstvu kiseline i karijesu [10, 11]. Smatra se da ima i antibakterijski efekat zarobljavanjem slobodnih jona i formiranjem remineralizacionih mikroprostora [12, 10].

Razlog zbog kojeg nekoliko studija pripisuje određeni nivo negativnog uticaja konvencionalnog nagrizanja gleđi kiselinom je proces demineralizacije koji se dešava nakon kiselinskog nagrizanja, pri čemu gleđ postaje prijemčljivija na zubni karijes, naročito kada demineralizovana površina ostane nezaštićena materijalom koji se koristi kao zubni zaptivač. Za prevazilaženje ovog problema sprovedene su brojne studije u potrazi za alternativnim postupcima za pripremu gleđi kao što je lasersko zračenje Er: YAG. Princip rada laserskog zračenja Er: YAG je „mehanički" sa mikroeksplozijama trenutnog isparavanja tkivne vode. Zadržavanje i dobra adaptacija zalivača sa površinom gleđi su faktori od suštinskog značaja za njihov uspeh. To je bio glavni razlog za ispitivanje karakteristika mikropukotina primenom zaptivača Heliosotineal-F na bazi smole, nakon različite pripreme okluzalne površine.

Ova studija se bavi ispitivanjem i upoređivanjem marginalnog curenja zalivača na bazi smole nakon kiselinskog nagrizanja i laserskog tretmana Er: YAG laserom.

MATERIJALI I METODE

Za realizaciju našeg istraživanja korišćeno je 30 intaktnih premolara i molara – bez karijesa, strukturnih anomalija i bez restauracija ekstrahovanih iz ortodontskih razloga – podeljenih u dve grupe (15 u svakoj). Nakon ekstrakcije uzorci su bili čuvani u fiziološkom rastvoru.

Distribucija grupa:

Prva grupa: fisure zalivene kompozitnim zalivačem (Helioseal-F, Ivoclar Vivadent AG, Lihtenštajn), prethodno nagrižene sa 37% ortofosfornom kiselinom.

Druga grupa: fisure zalivene kompozitnim zalivačem (Helioseal-F, Ivoclar Vivadent AG, Lihtenštajn), prethodno tretirane laserom Er: YAG (laser Fotona Lightwalker).

Za procenu mikropukotina, uzorci su prethodno očišćeni parodontalnim kiretama, podvrgnuti pranju, potapanju u 3% hidrogen peroksidu i sušenju vazdušnim mlazom iz pustera.

1. Prema uputstvu proizvođača, uzorci iz prve grupe su nagrizani sa 37% gelom ortofosforne kiseline u trajanju od 30 sekundi, isprani vodom, posušeni vazdušnim mlazom iz pustera i zaliveni Gerioseal-F na bazi smole. Zalivač je fotopolimerizovan tokom 20 sekundi halogenom lampom Bonart art-L2 talasne dužine oko 400 nm.
2. Okluzalna površina uzoraka iz druge grupe tretirana je laserskim zračenjem laserom Fotona Lightwalker (laser Erbium: YAG) intenziteta 6 V, energije od 300 mJ po impulsu i frekvencije 20 Hz. Nakon tretmana uzorci su osušeni vazdušnim mlazom i zaliveni prema uputstvima proizvođača kao uzorci iz prve grupe.

Vrhovi korenova su bili zapečaćeni roze voskom. Svi uzorci su zatim prekriveni sa dva sloja laka za nokte, osim površine od 1 mm oko ivice zalivača, i uronjeni u 2% rastvor metilensko plavo tokom 24 sata.

Nakon izlaganja boji, zubi su temeljno očišćeni pod tekućom vodom iz slavine u trajanju od pet minuta da bi se uklonila površinska boja, a zatim je lak za nokte uklonjen skalpelom. Dijamantskim diskom su pripremljeni uzdužni preseci u bukvalingvalnom pravcu. Preseci su bili približno 1,5 mm debljine kako bi se procenio stepen prodiranja boje ispod okluzalne površine. Korišćen je biokularni mikroskop sa uvećanjem 40× i fotografije su napravljene digitalnim fotoaparatom. Određen je stepen marginalnog prodora boje u četiri nivoa kao što su to uradili autori *Overbo R. C.* i *Raddal M.* [13]:

MARGINALNA PROPUSTLJIVOST

0 – Nema prodora
1 – Prodiranje do polovine dužine zalivača
2 – Prodiranje veća od jedne polovine, ne uključujući fisuru
3 – Prodiranje u fisuru

Podaci mikropropustljivosti za svaku grupu su poređeni korišćenjem Kraskal–Volisovog testa ($p = 0,05$). Značajne razlike procenjene su korišćenjem Man–Vitnijevog U testa (Z).

REZULTATI

Prva grupa je sadržala uzorke zalivene Helioseal-F, nagrižene 37% ortofosfornom kiselinom. Deset (66,67%) uzoraka je pokazalo mikropropustljivost ocene 0, dva (13,33%) uzorka mikropropustljivost ocene 1, a tri (20,00%) uzorka mikropropustljivost ocene 3. Druga grupa je sadržala uzorke zalivene Helioseal-F, gde je okluzalna površina prethodno pripremljena primenom laserskog zračenja Er: YAG laserom. Deset (66,67%) uzoraka je pokazalo mikropropustljivost ocene 0, jedan (6,67%) uzorak je pokazao mikropropustljivost ocene 1, dva (13,33%) uzorka mikropropustljivost ocene 2 i 2 (13,33%) uzorka mikropropustljivost ocene 3 (Tabela 1).

Vrednost $p > 0,05$ ($p = 0,98$) ukazuje da ne postoji statistički značajna razlika u mikropropustljivosti između uzoraka iz prve grupe (zalivenih zalivačem na bazi smole / nagrizanjem sa 37% gelom ortofosforne kiseline) i uzorcima iz druge grupe (zalivenih zalivačem na bazi smole / tretiranih laserskim zračenjem Er: YAG).

Fotografije opisuju nivo mikropropustljivosti na nekoliko preseka zuba koji su napravljeni tokom naše studije.

Fotografije 1, 2 i 3 napravljene su od uzoraka iz grupe 1, koji su zaliveni Helioseal-F i nagriženi 37% ortofosfornom kiselinom.

Slike 4, 5 and 6 su napravljene iz uzoraka iz druge grupe, gde je postavljen zalivač Helioseal-F, a površine prethodno pripremljene nagrizanjem kiselinom ili tretiranjem laserskim zračenjem Er: YAG.

DISKUSIJA

Međunarodna preporuka stomatologa i dečjih stomatologa je zalivanje mlečnih i stalnih molara kod dece i adolescenata kako bi se sprečio nastanak karijesa i minimiziralo napredovanje nekavitizovanih okluzalnih karijesnih lezija [14, 15]. Priprema gleđi raznim koncentracijama ortofosforne kiseline je uobičajena metoda koja ima određene nedostatke; stoga su i druge metode, poput laserske pripreme površine gleđi, stekle popularnost [9, 16,].

Efikasnost zalivača zavisi od njegove sposobnosti da postigne snažnu vezu sa gleđi na okluzalnoj površini. Ova veza je u velikoj meri odgovorna za nivo mikropropustljivosti u delu gleđ–zalivač. Glavni razlozi gubitka zalivača odnose se na osobinu mikrootpornosti, dubine prodiranja i postavljanja zalivača.

Princip rada lasera Er: YAG je „mehanički" sa mikroeksplozijama trenutnog isparavanja tkivne vode. Okluzalna površina gleđi apsorbuje lasersku energiju, koja dovodi do modifikacije površine, što poboljšava terapijski efekat.

Trenutno istraživanje je pokazalo da primena laserske ablacije kao dodatak tradicionalnom nagrizanju ortofosfornom kiselinom može poboljšati prijanjanje, prilagođavanje, zadržavanje i otpornost na mikropropustljivost zalivača na bazi smole [17, 18].

Nedavna klinička i *in vitro* istraživanja podržavaju upotrebu laserske ablacije pre nagrizanja gleđi kiselinom [17–20], mada ovi nalazi nisu jednoglasno potvrđeni [5, 21, 22].

Baigın i saradnici [6] (laser Er, Cr: ISGG, 2 V, 20 Hz) i Shahabi i saradnici [9] (laser Er: YAG, 100 mJ, 10 Hz) objavili su da lasersko nagrizanje može predstavljati alternativu konvencionalnom nagrizanju kiselinom, ali da nije eliminisalo potrebu za kiselinskim nagrizanjem pre stavljanja zalivača. *Hossain M.* i saradnici [23] saopštili su da stereomikroskopsko istraživanje pokazuje da laser potpuno uklanja ostatke nečistoća u jamama i fisurama, imajući prednost da dosegne do najužih, najdubljih delova pukotina. Autori su zaključili da lasersko uklanjanje plaka akumuliranog u fisurama može poboljšati zadržavanje zalivača.

Naši nalazi se podudaraju sa nalazima koje su objavili *Hossaina M.* i saradnici [23], koji smatraju da laser može poboljšati trajnost zalivača, a takođe su delimično usklađujući sa nalazima koje su objavili *Baigın* i saradnici [6] i *Shahabi* i saradnici [9] u rečenici u kojoj sugerišu da lasersko nagrizanje može predstavljati alternativu konvencionalnom nagrizanju kiselinom.

Nekoliko nalaza koji se tiču upotrebe lasera za nagrizanje gleđi su kontradiktorni. Neki istraživači su izjavili da lasersko zračenje nije sposobno da nagrize gleđ. *Martinez-Insua A*. i saradnici [24] zaključili su da su adhezivne sile slabije nakon primene lasera Er: YAG na gleđ u odnosu na površinu gleđi na koju je aplikovana kiselina. Ovo se odnosilo na pukotine koje su uočene na SEM slikama. *Tarcin B.* i saradnici [25] otkrili su da je čvrstoća veze značajno niža u grupi sa kiselinskim nagrizanjem od grupa Er, Cr: ISGG i Nd: YAG za oba korišćena sredstva za vezivanje. *Borsatto MC* i i saradnici [26] i *Lupi-Pegurier L.* i saradnici [27] potvrdili su da lasersko zračenje Er: YAG nije eliminisalo potrebu da se površina gleđi nagriza kiselinom pre nanošenja zalivača.

ZAKLJUČAK

Naša otkrića, koja se tiču marginalne mikropropustljivosti zalivača na bazi smole, ukazuju da lasersko zračenje Er: YAG jamica i fisura može pružiti snažnu vezu gleđi i zalivača, što može sprečiti mikrocurenje i može se preporučiti kao alternativna metoda za pripremu jamica i fisura pre aplikovanja zalivača.