

The Effect of Temporary Filling Materials on the Microleakage in Endodontically Treated Teeth

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SUMMARY

Introduction Besides anatomic-morphological characteristics of the root canal system, instrumentation techniques, obturation materials as well as temporary filling materials can influence the coronal microleakage. The aim of this study was to assess in vitro coronal microleakage of temporary filling materials in endodontically treated teeth by the method of colored solutions.

Material and Methods Forty extracted human teeth (single-rooted and multi-rooted) divided into two groups of (intact and caries affected) were used. The root canals were instrumented by step-back preparation technique and 2.5% NaOCl as irrigant solution. Obturation was performed by lateral condensation technique with Apexit paste and gutta-percha. Cavit and Glass Ionomer Cement were used as temporary filling materials. The solution of 50% AgNO₃ was used for microleakage assessment. The penetration of the color was evaluated using Light Microscope.

Results Of intact teeth, 60% temporarily filled by Cavit showed the color penetration, while only 25% of the teeth temporarily filled by combination of GIC and Cavit. The difference was statistically significant ($p < 0.05$). In caries affected teeth, the penetration of the color was observed in 55% of the samples when Cavit was used and in 32% when combination of GIC and Cavit was used as temporary filling material. The difference was statistically significant ($p < 0.05$). Less color penetration occurred in single-rooted than in multi-rooted teeth in both groups, but the differences were not statistically significant.

Conclusion Glass Ionomer Cements in combination with Cavit provide better sealing of endodontically treated teeth. The least color penetration was observed in intact single-rooted teeth.

Keywords: coronal microleakage; temporary filling materials; Glass Ionomer Cement; Cavit

INTRODUCTION

For a long time, apical microleakage was considered as a main issue in endodontically treated teeth. In the recent decades, many published articles have been dealing with the quality of the proximal as well as coronal sealing of the root canal space after obturation [1, 2]. The purpose of endodontic treatment is satisfactory cleaning and shaping of the root canal as well as good quality three-dimensional obturation. Besides anatomic-morphological characteristics of the root canal system, paste for obturation, instrumentation and obturation techniques, temporary filling materials can also influence the coronal microleakage [3].

Caries removal, access cavity preparation, instrumentation and cavity preparation for the final tooth restoration often require extensive removal of the tooth substance. Coronal part of the tooth is usually weak and the walls are thin, therefore it is necessary to choose an appropriate

material for restoration which will also provide good coronal sealing. Minimum thickness of the temporary material should be 4 mm but sometimes in clinical conditions due to great loss of tooth substance it is difficult to achieve [4].

Coronal microleakage by inadequate temporary material or inadequate obturation of the root canal is directly related to the failure of endodontic therapy. If the temporary material is not placed properly or it is fractured during mastication, due to penetration of saliva and microorganisms from the oral cavity, apical periodontal inflammation can occur. For these reasons it is considered that endodontically treated teeth should be reconstructed by direct filling or by prosthetic crown within 30 days after the root canal obturation.

The aim of this study was to assess in vitro coronal microleakage of temporary filling materials Cavit and combination of Glass Ionomer Cement (GIC) and Cavit by the method of colored solutions in endodontically treated teeth.

MATERIAL AND METHODS

Experiments were done using 40 intact and caries affected human teeth (single-rooted and multi-rooted) extracted for various reasons. Any tissue remnants and calculi were removed from the teeth. The teeth were rinsed under the tap water and kept in alcohol up to the start of the experiments. Access cavity was prepared in each tooth, in the teeth affected by caries; first, it was removed using carbide drill and then access cavity was formed. Instrumentation of the coronary third of the canals was done by Gates Glidden instruments sizes from 1 to 4 (VDW GmbH Munich, Germany) [5, 6]. Endodontic procedure was the same for all experimental groups. After access cavity preparation, remained pulp tissue was removed by barbed-broaches. Working length was determined 1 mm shorter than the length of the reamer #15 when its tip came to the apex of the tooth. Instrumentation of the canals was done by STEP BACK technique using manual instruments (reamers and files) followed by copious irrigations with 2.5% NaOCl solution. After instrumentation and irrigation was done, root canals were dried using paper points. Obturation was performed using lateral condensation technique and Apexit paste.

The teeth were divided into two experimental groups A (intact) and B (caries) with 20 teeth in each. Two subgroups of 10 single-rooted teeth and 10 multi-rooted teeth were formed. After gutta-percha and paste removal from the root canal opening, Cavit or combination of Cavit and GIC were used as temporary filling materials. After temporary reconstruction of the coronal part of the tooth, all the teeth were kept at 37°C in humid conditions. After 7 days, all the teeth were coated with two layers of nail polish, except the belt of 1 mm width on the junction of temporary filling material Cavit and the cavity wall. Coronal part of the teeth was immersed in 50% solution AgNO₃ for 6 hours, then they were rinsed

under running water and immersed into the film developer for 2 hours. The teeth were longitudinally split by 6 mm diameter diamond disc, in mesio-distal direction. The results were obtained using micrometer ruler under 6 times magnification.

RESULTS

The average color penetration in the intact single-rooted teeth when Cavit was used as temporary filling material was 40 µm while in the teeth where combination of GIC and Cavit was used, it was 12 µm. This difference was statistically significant ($p < 0.05$) (Table 1). The average penetration of the color in the intact multi-rooted teeth when Cavit was used as temporary filling material was 34 µm while it was 15 µm in the teeth where combination of GIC and Cavit was used. The results suggested significant difference between the two tested groups ($p < 0.05$) (Table 1). Analysis of the results also showed the color penetration was present in 30% of the single-rooted intact teeth and 60% of the multi-rooted intact teeth. This difference was statistically significant ($p < 0.05$). The results showed that the penetration of the color in the intact teeth, temporarily closed by Cavit was observed in 60% of the teeth while in the corresponding group of the teeth temporarily closed by combination of GIC and Cavit it was seen in 25% of the samples. The difference was statistically significant ($p < 0.05$).

The average penetration of the color in the caries affected single-rooted teeth temporarily closed with Cavit was 26 µm while in the teeth where combination of GIC and Cavit was used, it was 23 µm. The difference was not statistically significant (Table 2). The average penetration of the color in the caries affected multi-rooted teeth where Cavit was used as temporary filling material was 33 µm while in the teeth when combination of GIC and Cavit

Table 1. The average color penetration in the intact teeth depending on the type of teeth and type of temporary filling material.

Tabela 1. Prosečan prodor boje kod intaktnih zuba u zavisnosti od vrste zuba i vrste privremenog ispuna.

Teeth Zubi	Material Materijal	N	\bar{X}	SD	SE	Med	Min	Max
Single-rooted Jednokoreni	Cavit	10	40.00	40.28	12.74	35.00	0.00	100.00
	GIC + Cavit	10	12.00	20.98	6.63	0.00	0.00	60.00
Multi-rooted Višekoreni	Cavit	10	34.00	36.58	11.57	30.00	0.00	100.00
	GIC + Cavit	10	15.00	23.71	7.19	0.00	0.00	80.00

N – number of teeth; \bar{X} – mean value; SD – standard deviation; SE – standard error; Med – median; Min – minimal value; Max – maximal value; GIC – glass ionomer cement

N – broj uzoraka; \bar{X} – srednja vrednost; SD – standardna devijacija; SE – standardna greška; Med – medijana; Min – najmanja vrednost; Max – najveća vrednost; GIC – glasjonomer-cement

Table 2. The average penetration of the color of teeth affected by caries depending on the type of tooth and type of temporary material.

Tabela 2. Prosečan prodor boje kod zuba zahvaćenih karijesom u zavisnosti od vrste zuba i vrste privremenog ispuna.

Teeth Zubi	Material Materijal	N	\bar{X}	SD	SE	Med	Min	Max
Single-rooted Jednokoreni	Cavit	10	26.00	35.34	11.18	0.00	0.00	80.00
	GIC + Cavit	10	23.00	28.30	8.95	5.00	0.00	60.00
Multi-rooted Višekoreni	Cavit	10	33.00	37.58	8.40	0.00	0.00	80.00
	GIC + Cavit	10	17.50	24.89	5.57	15.00	0.00	60.00

N – number of teeth; \bar{X} – mean value; SD – standard deviation; SE – standard error; Med – median; Min – minimal value; Max – maximal value; GIC – glass ionomer cement

N – broj uzoraka; \bar{X} – srednja vrednost; SD – standardna devijacija; SE – standardna greška; Med – medijana; Min – najmanja vrednost; Max – najveća vrednost; GIC – glasjonomer-cement

was used it was 17.5 μm . This difference was not statistically significant (Table 2). Analysis of the results showed that in single-rooted teeth affected by dental caries, the color penetration was observed in 40% of the samples and in multi-rooted caries affected teeth in 50% of the teeth. The obtained difference was not statistically significant. Analysis of the results showed the penetration of the color in 55% of the caries affected samples where Cavit was used, while in the caries affected teeth where combination of Cavit and GIC was used as temporary filling material, it was noted in 32% of the teeth. This difference was statistically significant ($p < 0.05$).

DISCUSSION

Despite the anatomical differences between apical and coronal part of the root canal, research regarding coronal microleakage is quite behind those on the quality of apical sealing. The quality of coronal sealing depends on different factors, primarily on the quality of a temporary filling which should appropriately seal the cavity, the canal system anatomy, preparation technique [7, 8, 9], obturation method [10] and type of the sealer [1, 11, 12].

This study evaluated coronal microleakage of endodontically treated teeth whose crowns were temporarily sealed with Cavit only or combination of GIC and Cavit. The results showed that the linear penetration of the color was the shortest in single-rooted teeth either intact or caries affected. This could be attributed to the configuration of the pulp cavity, especially coronal part that affected the passive penetration of color. Single-rooted teeth have wider canals, accessible to instrumentation and irrigation as well as obturation while in the multi-rooted teeth, endodontic treatment is more difficult because of the presence of multiple canals which affect not only the quality of obturation but also microleakage [13, 14]. Size of the access cavity also plays a big role in coronal microleakage. Single-rooted teeth have smaller access cavity and slighter surface is exposed to microbial agents from the oral environment while in the multi-rooted teeth, wider access cavity is necessary, in order to provide better instrumentation and easier manipulation by manual or rotary instruments [15].

The analysis of the results showed the shortest linear penetration of the color in coronal part of intact teeth. This can be explained by the fact that the access cavity has satisfactory thickness and height of walls, thus providing a good retention of temporary filling. That way, good quality coronal sealing is obtained with temporary filling even when the layer is thinner than 4 mm. Lateral condensation, used in this study, is the most commonly used technique because it gives satisfactory results in clinical conditions. De-Deus et al. [16] examined whether the method of obturation in oval shaped canals affects the marginal microleakage. Obturation was done by method of lateral condensation, system B and Thermafil technique. The samples were subjected to the influence of saliva and observed for 15 weeks. Microscopic analysis, after cutting teeth, showed microleakage in 30% of the samples when

lateral condensation and System B were used and in 20% of the samples when Thermafil was used, respectively. A significant difference between the experimental groups (obturation techniques) was not observed.

Complex techniques and systems for permanent obturation that are demanding to perform can lead to errors during manipulation and therefore can give worse quality of the obturation. The least penetration of the color was observed in intact single-rooted teeth after application of GIC and then application of Cavit of 4 mm thickness. In the teeth where it was not possible to provide the necessary thickness of the temporary filling due to caries tissue loss or access cavity preparation, the color penetration was much greater. The difference was statistically significant only between intact teeth, temporarily closed by a combination of GIC and Cavit and intact teeth temporarily closed by Cavit only, which points to the importance of GIC as a barrier against penetration of oral fluids and microorganisms [17]. Material for temporary restorations should provide a permanent airtight seal until permanent restoration is placed. Numerous studies assessed a various features of the temporary materials to reduce coronal microleakage as much as possible.

Chailertvanitkul et al. examined the effect of resin-reinforced glass ionomer Vitrebond as liner above obturation material in endodontically treated teeth. The teeth were tested for coronal microleakage using a microbiological marker that contains anaerobic bacteria, *Streptococcus* and *Fusobacterium nucleatum*. The teeth were tested each day during 60 days for coronal microleakage. Samples that had Vitrebond liner did not show coronal microleakage within 60 days, while in the other teeth where Vitrebond was not placed, microleakage was registered in all 60 samples. It was concluded that the resin modified GIC is good barrier against bacterial penetration after obturation [6].

Imura et al. examined coronal microleakage of the three commonly used temporary filling materials: gutta-percha, Cavit and IRM. The results showed that none of these three materials can prevent coronal microleakage and bacterial penetration for more than 22 days. Conclusion was that Cavit was superior to gutta-percha and IRM [17].

Pisano et al. examined the ability of Cavit, IRM and Super-EBA to prevent liquid leaking into the canal. After chemomechanical instrumentation, the teeth were obturated by lateral condensation technique. Gutta-percha was removed 3.5 mm from the canal orifice and one of the three materials (Cavit, IRM, Super-EBA) was placed. After 90 days in the Cavit group, bacterial penetration was found in 15% of the samples while in the groups with IRM and Super-EBA in 35% of the samples [18]. It was confirmed that the permanent filling must be placed within 30 days of obturation and must provide good coronal sealing [3].

Yatsushiro et al. have done a longitudinal study in which, by the fluid filtering system, investigated the ability of MTA (mineral trioxide aggregate) and amalgam to provide adequate coronal sealing. They prepared cavity class I with the depth of 3mm on 33 teeth, removed gutta-percha from the canal (2 mm) and placed MTA or amalgam. They followed liquid penetration after 1, 2, 3, 4, 8,

12, 16, 20 and 24 weeks. It was concluded that amalgam had greater microleakage after 4 weeks and greater variability compared to the MTA [19].

CONCLUSION

The results of the study showed that the Glass Ionomer Cement in combination with the Cavit provides better coronal sealing in endodontically treated teeth compared to the teeth temporarily filled by Cavit only. The lowest penetration of the color was observed in intact single-rooted teeth.

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Uticaj sredstava za privremeno zatvaranje na kruničnu mikropropustljivost endodontski lečenih zuba

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KRATAK SADRŽAJ

Uvod Osim anatomske-morfološke osobine kanalnog sistema, na koronarno mikropropuštanje mogu uticati i tehnike preparacije kanala korena, sredstva za opturaciju i izbor sredstava za privremeno zatvaranje kaviteta. Cilj rada je bio da se metodom bojjenih rastvora kod endodontski lečenih zuba u uslovima *in vitro* ispita kvalitet krunične mikropropustljivosti sredstava za privremeno zatvaranje kaviteta.

Materijal i metode rada U studiji je korišćeno 40 ekstrahovanih (jednokoreni i višekoreni) humanih zuba (intaktnih i karijesno promjenjenih). U preparaciji kanala je korišćena tehnika *step-back*, a kao irigans dvoiprocenatni rastvor NaOCl. Opturacija je urađena metodom lateralne kompakcije primenom paste Apexit i gutaperke. Za privremeno zatvaranje zuba korišćeni su Cavit i glasjonomer-cement. Za procenu mikropropustljivosti korišćen je pedesetoprocenatni rastvor AgNO₃. Prodor boje je procenjen na svetlosnom mikroskopu.

Rezultati Kod intaktnih zuba privremeno zatvorenih Cavit-om prodor boje uočen je u 60% uzoraka, dok je kod zuba privremeno zatvorenih kombinacijom glasjonomer-cementa i Cavit-a bio 25%. Razlika je bila statistički značajna ($p < 0,05$). Kod zuba zahvaćenih karijesom čija je krunica privremeno zatvorena Cavit-om prodor boje je uočen u 55% uzoraka, dok je kod uzoraka privremeno zatvorenih kombinacijom glasjonomer-cementa i Cavit-a prodor boje zabeležen u 32% uzoraka. Razlika je bila statistički značajna ($p < 0,05$). Prodor boje kod jednokoreni zuba bio manji nego kod višekoreni u obe grupe, ali razlike nisu bile statistički značajne.

Zaključak Glasjonomer-cementi u kombinaciji sa Cavit-om obezbeđuju bolje krunično zaptivanje endodontski lečenog zuba. Najmanji prodor boje je uočen kod intaktnih jednokoreni zuba.

Cljučne reči: krunična mikropropustljivost; sredstva za privremeno zatvaranje; glasjonomer-cement

UVOD

Za primarni problem endodontski lečenih zuba dugo se smatralo apikalno mikropropuštanje. Međutim, poslednjih decenija dosta je objavljenih radova koji se bave kvalitetom kako bočnog, tako i kruničnog zaptivanja kanalnog prostora nakon opturacije kanala [1, 2]. Svrha endodontskog lečenja je dobro čišćenje i oblikovanje kanala korena zuba, koje uz kvalitetnu trodimenzionalnu opturaciju kanala treba da obezbedi efikasnu endodontsku intervenciju. Osim anatomske-morfološke osobine kanalnog sistema, na koronarno mikropropuštanje mogu uticati i paste za opturaciju kanala, tehnike preparacije i punjenja kanala, odnosno izbor sredstava za privremeno zatvaranje kaviteta [3].

Uklanjanje karijesa, preparacija pristupnog kaviteta, instrumentacija kanala i priprema kaviteta za konačnu restauraciju krunice zuba često zahtevaju opsežno uklanjanje zubne supstance. Krunica zuba je time obično veoma oslabljena i zidovi istanjeni, pa je neophodno odabrati odgovarajući materijal za restauraciju krunice koji će obezbediti dobro krunično zaptivanje. Minimalna debljina sredstva za privremeno zatvaranje kaviteta trebalo bi da bude 4 mm, što je nekad u kliničkim uslovima, zbog velikog gubitka zubne supstance, teško ostvariti [4].

Koronarno mikropropuštanje preko neadekvatnog privremenog ispuna za restauraciju krunice ili neadekvatne opturacije kanala u direktnoj je vezi s neuspelom endodontskog lečenja. Ukoliko privremeni materijal nije dobro postavljen ili dođe do lomljenja tokom žvakanja usled prodora pljuvačke i mikroorganizama iz usne duplje, posledica može biti upala apikalnog periodoncijuma. Stoga se smatra da endodontski lečeni zub

treba konzervativno ili protetički zbrinuti u roku od 30 dana od konačne opturacije kanala.

Cilj rada je bio da se metodom bojjenih rastvora u uslovima *in vitro* proveri kvalitet kruničnog mikropropuštanja endodontski lečenih zuba nakon privremenog zatvaranja Cavit-om, odnosno kombinacijom glasjonomer-cementa (GJC) i Cavit-a.

MATERIJAL I METODE RADA

Ispitivanja su obavljena na 40 intaktnih i karijesom zahvaćenih zuba humanog porekla (jednokoreni i višekoreni zubi) ekstrahovanih iz različitih razloga. Sa zuba su uklonjeni ostaci mekog tkiva i kamenca. Zubi su isprani pod mlazom vode i do početka eksperimenta čuvani u alkoholu. Kod svih zuba su formirani pristupni kaviteti, pri čemu je kod zuba zahvaćenih karijesom prvo okruglim karbidnim svrdlom uklanjan karijes, a zatim formiran pristupni kavitet. Koronarna trećina korenskih kanala je instrumentirana Gejts-Glidenovim (*Gates-Glidden*) svrdlima veličine od 1 do 4 (*VDW GmbH München, Germany*) [5, 6]. Endodontski postupak je bio isti za sve eksperimentalne grupe. Nakon formiranog pristupnog kaviteta zaostalo pulpno tkivo je uklonjeno ekstirpatorima. Radna dužina je određivana tako da je bila za 1 mm kraća od dužine proširivača br. 15 kada se njegov vrh pojavio na apeksu zuba. Biomehanička obrada kanala je izvedena primenom tehnike *step-back* pomoću ručnih proširivača i turpija uz obilnu irigaciju dvoiprocenatnim rastvorom NaOCl. Tako pripremljeni kanali su posušivani papirnim poenima i potom opturirani metodom lateralne kompakcije uz primenu paste Apexit.

Zubi su potom svrstani u dve eksperimentalne grupe: 20 intaktnih zuba u grupu A, a 20 karijesnih zuba u grupu B. Svaka grupa je obuhvatila po dve podgrupe s jednokorenim (10) i višekorenim zubima (10). U svim ispitivanim grupama privremeno zatvaranje zuba je urađeno samo Cavit-om ili kombinacijom GJC i Cavit-a nakon uklanjanja punjenja 2-3 mm od ulaza u kanal. Posle privremene rekonstrukcije krunicnog dela zuba, svih 40 uzoraka je čuvano na temperaturi od 37°C u uslovima relativne vlažnosti. Sedam dana kasnije svi zubi su premazani sa dva sloja laka za nokte, izuzev pojasa širine 1 mm na spoju Cavit-a i zida kaviteta. Zubi su zatim uronjeni krunicnim delom u pedesetoprocetni rastvor AgNO₃ u trajanju od šest sati, nakon čega su isprani pod mlazom vode i potopljeni u fotorazvijajući u trajanju od dva sata. Svi uzorci zuba su zatim uzdužno presecani dijamantskim diskom prečnika 6 mm u meziodistalnom pravcu. Očitavanje rezultata je vršeno stereolupom s mikrometarskim razmernikom u okularu i pri uvećanju od šest puta.

REZULTATI

Prosečan prodor boje kod intaktnih jednokorenih zuba zatvorenih Cavit-om bio je 40.00 µm, a kod zuba zatvorenih kombinacijom GJC i Cavit-a 12 µm; ova razlika je bila statistički značajna ($p < 0,05$) (Tabela 1). Prosečan prodor boje kod intaktnih višekorenih zuba zatvorenih Cavit-om bio je 34.00 µm, a kod zuba zatvorenih kombinacijom GJC i Cavit-a 15 µm. Dobijena razlika je ukazala na to da postoji statistička značajnost ($p < 0,05$) između dve grupe ispitanih zuba (Tabela 1). Analiza rezultata je takođe pokazala da je prodor boje zabeležen u 30% intaktnih jednokorenih zuba i 60% višekorenih zuba. Ova razlika je bila statistički značajna ($p < 0,05$). Rezultati pokazuju da je prodor boje kod intaktnih zuba koji su privremeno zatvoreni Cavit-om uočen u 60% uzoraka, dok je kod zuba iste grupe privremeno zatvorenih kombinacijom GJC i Cavit-a prodor boje zabeležen u 25% uzoraka. I ova razlika je bila statistički značajna ($p < 0,05$).

Prosečan prodor boje kod jednokorenih zuba zahvaćenih karijesom koji su zatvoreni Cavit-om bio je 26.00 µm, a kod zuba zatvorenih kombinacijom GJC i Cavit-a 23 µm. Razlika u dobijenim rezultatima nije bila statistički značajna (Tabela 2). Prosečan prodor boje kod višekorenih zuba zahvaćenih karijesom koji su zatvoreni Cavit-om bio je 33.00 µm, a kod zuba zatvorenih kombinacijom GJC i Cavit-a 17,5 µm. Ni ova razlika nije bila statistički značajna (Tabela 2). Analiza rezultata je pokazala i da je kod jednokorenih zuba zahvaćenih karijesom prodor boje uočen u 40% uzoraka, a kod višekorenih u 50%, ali razlika nije bila statistički značajna. Analiza dobijenih rezultata je pokazala prodor boje u 55% uzoraka privremeno zatvorenih Cavit-om, dok je kod zuba čija je krunica zatvorena kombinacijom GJC i Cavit-a prodor boje zabeležen u 32% uzoraka. Ova razlika je, međutim, bila statistički značajna ($p < 0,05$).

DISKUSIJA

Uprkos anatomskim razlikama između apeksnog i krunicnog dela kanala korena zuba, istraživanja krunicnog mikropropuštanja zuba znatno zaostaju za onima o kvalitetu apeksnog

zaptivanja. Na kvalitet krunicnog mikropropuštanja utiču mnogi faktori, ali pre svega sposobnost privremenog ispuna da hermetički zatvori kavitet, zatim anatomija kanalnog sistema, tehnika preparacije [7, 8, 9], metoda opturacije kanala [10], te vrsta korišćenog silera [1, 11, 12].

U našem istraživanju je analizirana krunicna mikropropustljivost endodontski lečenih zuba čije su krunice privremeno zatvorene samo Cavit-om ili GJC i Cavit-om. Rezultati su pokazali da je linearni prodor boje bio najmanji kod jednokorenih zuba, bilo da pripadaju grupi intaktnih ili zuba zahvaćenih karijesom. Ovo bi se moglo pripisati konfiguraciji kavuma pulpe, pogotovo korenskog dela, koji utiče na pasivni prodor boje. Kod jednokorenih zuba kanali su široki, pristupačni za mehaničko-hemijsku obradu i opturaciju, dok je kod višekorenih zuba to otežano zbog postojanja više kanala i može imati uticaja na kvalitet opturacije, a time i na mikropropuštanje [13, 14]. Veličina pristupnog kaviteta takođe igra veliku ulogu u mikrocurenju. Jednokoreni zubi imaju manje pristupne kavitete, te je manja površina izložena mikrobnim agensima iz oralne sredine, dok je kod višekorenih zuba neophodno preparirati širi pristupni kavitet, ne štedeći zubnu supstancu, kako bi se obezbedile kvalitetna obrada kanala i lakša manipulacija ručnim ili mašinskim instrumentima [15].

Analizom dobijenih rezultata utvrđen je najmanji linearni prodor boje u krunicnom delu intaktnih zuba. Ovo se objašnjava činjenicom da pristupni kavitet ima potrebnu debljinu i visinu zidova, čime se obezbeđuje dobra retencija privremenog ispuna za zidove kaviteta. Na taj način se osigurava dobro koronarno zaptivanje privremenim ispunom čak i kada je sloj tanji od 4 mm.

Tehnika lateralne kompakcije, koja je primenjena u ovoj studiji, najčešće je korišćena tehnika jer daje zadovoljavajuće rezultate u kliničkim uslovima. De Deus (*De-Deus*) i saradnici [16] su u svojim istraživanjima ispitivali da li način opturacije kod ovalno instrumentiranih kanala utiče na ivično mikropropuštanje. Zubi su opturirani metodom lateralne kompakcije i tehnikama sistem B i Thermafil. Uzorci su podvrgnuti uticaju pljuvačke i posmatrani 15 nedelja. Mikroskopskom analizom dobijenih preparata nakon sečenja zuba mikropropuštanje je uočeno u 30% uzoraka opturiranih metodom lateralne kondenzacije i tehnikom sistem B, odnosno u 20% uzoraka opturiranih tehnikom Thermafil. Značajna razlika između eksperimentalnih grupa (opturacionih tehnika) nije uočena.

Tehnike i sistemi konačnog punjenja koji su složeni za primenu mogu dovesti do grešaka u izvođenju opturacije, što za posledicu ima nekvalitetno punjenje. Najmanji prodor boje je uočen kod intaktnih jednokorenih zuba posle primene GJC i potom privremenog zatvaranja Cavit-om debljine 4 mm. Kod zuba kod kojih nije bilo moguće obezbediti potrebnu debljinu privremenog ispuna zbog izgubljenog tkiva usled karijesa i preparacije pristupnih kaviteta prodor boje je bio znatno veći. Razlika je bila statistički značajna samo između intaktnih zuba koji su privremeno zatvoreni kombinacijom GJC i Cavit-a i intaktnih zuba privremeno zatvorenih samo Cavit-om, što ukazuje na važnost GJC kao barijere protiv prodora oralnih fluida i mikroorganizama [17]. Privremeni materijal za restauraciju krunice treba da obezbedi trajno hermetičko zaptivanje kaviteta dok se ne zameni konačnim ispunom. Brojne studije su ispitivale osobine raznih privremenih materijala, kako bi se krunicno mikropropuštanje svelo na najmanju moguću meru.

Šailervantikul (*Chailertvantikul*) i saradnici [6] su ispitivali efekat glasjonomer Vitrebonda ojačanog smolom kao lajnera kod opturiranih kanala. Zubi su ispitani na koronarno mikropropuštanje korišćenjem mikrobiološkog markera koji je sastavljen od anaerobnih streptokoka i bakterije *Fusobacterium nucleatum*. Uzorci su svakodnevno ispitivani na krunično mikropropuštanje tokom 60 dana. Uzorci sa lajnerom Vitrebond nisu pokazali mikropropuštanje tokom 60 dana, dok je kod drugih zuba gde nije korišćen ovaj glasjonomer mikropropuštanje uočeno kod svih 60 uzoraka. Zaključeno je da je smolom modifikovan glasjonomer dobra barijera prodoru bakterija nakon opturacije kanala.

Imura (*Imura*) i saradnici [17] su ispitivali kruničnu propustljivost tri najčešće korišćena privremena ispuna – gutaperke, Cavit-a i IRM-a – nakon opturacije metodom lateralne kompaktacije. Rezultati su pokazali da nijedan od ova tri materijala ne može sprečiti krunično mikropropuštanje i prodor mikroorganizama duže od 22 dana. Zaključeno je da je Cavit znatno bolji od gutaperke i IRM-a.

Pizano (*Pisano*) i saradnici [18] su ispitivali sposobnost Cavit-a, IRM-a i Super-EBA da speče curenje tečnosti u kanal korena. Nakon hemomehaničke obrade zubi su opturirani metodom lateralne kompaktacije. Gutaperka je uklanjana 3,5 mm iz kanala i postavljan je jedan od tri materijala. Nakon 90 dana u

grupi sa Cavit-om utvrđen je prodor mikroorganizama u 15% uzoraka, a u grupama sa IRM-om i Super-EBA u 35% uzoraka. Potvrđeno je takođe da konačni ispun mora biti postavljen u roku od 30 dana od završetka opturacije, te da mora obezbediti dobro krunično zaptivanje [3].

Jacuširo (*Yatsushiro*) i saradnici [19] su izveli dugoročnu studiju u kojoj su pomoću fluid-filtracionog sistema ispitali sposobnost mineralnog trioksidnog agregata (MTA) i amalgama da obezbede dobro krunično zaptivanje. Oni su na 33 zuba preparirali kavitete prve klase duboke 3 mm, zatim uklanjali gutaperku iz kanala (2 mm) i postavljali MTA ili amalgam. Prodor tečnosti su pratili nakon 1, 2, 3, 4, 8, 12, 16, 20 i 24 nedelje. Zaključeno je da amalgam pokazuje visok stepen mikropropuštanja posle četiri sedmice i visoku varijabilnost u poređenju s MTA.

ZAKLJUČAK

Rezultati istraživanja su pokazali da GJC u kombinaciji s Cavit-om obezbeđuju bolje krunično zaptivanje endodontski lečenih zuba u odnosu na zube privremeno zatvorene samo Cavit-om. Najmanji prodor boje je uočen kod intaktnih jednokorenih zuba.