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Propusnost punila Apexit Plus i GuttaFlow

The Leakage of Apexit Plus and GuttaFlow Sealers

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Sažetak

Svrha rada bila je usporediti propusnost dvaju punila korijenskih kanala - Apexit Plusa i GuttaFlowa. **Materijali i metode:** U istraživanju se koristio uzorak od 26 jednokorijenskih, ekstrahiranih trajnih zuba. Svi njihovi kanali bili su obrađeni tehnikom ProTaper, a uzorci podijeljeni u dvije skupine po 10 zuba. Korijenski kanali prve skupine bili su ispunjeni tehnikom lateralne kondenzacije s gutaperkinim štapićima i punilom Apexit Plus. Druga skupina uzoraka bila je napunjena punilom GuttaFlow. Preostalih šest uzoraka koristili su se kao kontrolna skupina. Propusnost ispuna korijenskih kanala u uzorcima ispitana je konstrukcijom za prijenos tekućine 24 sata nakon punjenja i nakon termocikliranja. **Rezultati i zaključak:** Rezultati istraživanja pokazali su statistički manju propusnost punila GuttaFlow u usporedbi s Apexit Plusom 24 sata nakon punjenja i termocikliranja (obje usporedbe: Kruskal-Wallisova ANOVA, $p<0,0002$). Apexit Plus je statistički značajno više propuštao nakon procesa termocikliranja u odnosu prema rezultatima dobivenima nakon 24 sata, a prije termocikliranja ($p=0,011$). Kod uzoraka punjenih GuttaFlow-om nije ustanovljeno statistički značajno propuštanje prije termocikliranja i nakon toga postupka (Friedmaova ANOVA, $p=0,739$). U ovom je istraživanju GuttaFlow manje propuštao u odnosu prema punilu Apexit Plusu.

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Ključne riječi
GuttaFlow; Apexit Plus; model prijenosa tekućina; korijenski kanal; materijali za punjenje

Uvod

Svrha obrade korijenskih kanala je čišćenje i instrumentacija, uklanjanje organskih tvari i dobro brtvljenje endodontskog prostora.

Mikropropuštanje između dentinske stijenke i punjenja korijenskog kanala može nepovoljno utjecati na ishod endodontskog liječenja (1). Gutaperka štapići i punilo koriste se za dugotrajno punjenje korijenskih kanala. Novo tekuće punilo - GuttaFlow (Coltene/Whaledent, Altstatten, Švicarska), silikonsko je i sadržava čestice gutaperke, a stvrdnjava se za deset minuta. Prema podacima proizvođača, to

Introduction

The purpose of root canal treatment is to clean and shape the root canal, removing all organic material, and to seal the endodontic space.

It is well known that microleakage between a root canal filling and root canal walls may adversely affect the results of root canal treatment (1). Commonly, gutta-percha and a sealer are used to fill the root canal system for a long period of time. The new root canal filling sealer GuttaFlow (Coltene/Whaledent, Altstatten, Switzerland) is silicon based and contains gutta-percha particles as filler. The mate-

punilo bolje brtvi i dobro se adaptira baš zato što je tekuće i blago povećava volumen tijekom stvrdnjavanja. Apexit Plus (Ivoclar, Vivadent, Schaan, Liechenstein) razmjerno je novo punilo za korijenske kanale, a proizvedeno je na temelju kalcijeva hidroksida koji – kako ističe proizvođač - osigurava dobro i dugotrajno brtvljenje korijenskog kanala zahvaljujući blagoj ekspanziji tijekom stvrdnjavanja i slaboj topljivosti. Ipak, propusnost punjenja korijenskih kanala može se s vremenom povećati zbog djelomičnog otapanja, što su u svojem radu potvrdili Kontakiotis i njegovi suradnici. (2). U mnogobrojnim istraživanjima uspoređene su različite tehnike punjenja i različita punila kao što su: AH 26 i Sealapex (3), AH26, Ketac-Endo i Tubuli-Seal (4) te AH26 i AH Plus (5). Osim tehnike punjenja i punila, važan je i oblik obrađenoga korijenskog kanala (6). Većina punila potencijalno štetno djeluje na živa tkiva, barem tijekom stvrdnjavanja. Za punila na bazi kalcijeva hidroksida i silikona pretpostavlja se da su biokompatibilna (7,8), pa je zbog toga svrha istraživanja bila ustanoviti propusnost dvaju različitih punila - Apexit Plusa na temelju kalcijeva hidroksida i silikonskoga GuttaFlowa. Mjerenja su obavljena 24 sata nakon unosa u korijenski kanal, a zatim su uzorci termociklirani te su mjerenja ponovljena.

Materijali i metode

Odabir i instrumentacija zuba

U istraživanju se koristio uzorak od dvadeset šest jednokorijenskih zuba s potpuno razvijenim korijenima, a dobiveni su u Zavodu za oralnu kirurgiju Stomatološkog fakulteta Sveučilišta u Zagrebu. Odmah nakon što su bili izvađeni, pohranjeni su u 0,9-postotnu otopinu natrijeva klorida (NaCl) kako bi se izbjeglo isušivanje. Zubne krune odrezane su dijamantnim svrdlom na caklinsko-cementnom spojištu. Uzorci su zatim mehanički očišćeni okruglim, čeličnim svrdlom. Duljina svakog kanala bila je određena proširivačem veličine 15 (K-file, ISO # 15) (Maillefer, Ballaigues, Švicarska), tako da je vrh instrumenta bio pušten da prođe kroz obrađeni apeksni otvor, a zatim je povučen milimetar unatrag. Tako određena duljina rabljena je kao radna. Korijenski kanali ručno su obrađeni do veličine #25 K instrumenta, do pune radne dužine. Nakon toga su svi bili instrumentirani ProTaper instrumentima veličine S1, S2, F1, F2, F3 (Dentsply, Maillefer) uz Glyde kao lubrikant (Dentsply, Tulsa, SAD). Tijekom strojne instrumentacije prosječna je brzina bila 300 okretaja u minuti. Kanali su se ispirali nakon svakog instrumenta s tek pripremljenim 2-postotrial is flowable and sets within 10 min. According to the manufacturer, material gives a better seal and good adaptability because of the increased flowability and the fact that it expands slightly on setting. Apexit Plus (Ivoclar, Vivadent, Schaan, Liechenstein) is also a new root canal filling material based on calcium-hydroxide, which according to the manufacturer enables good and durable sealing of the root canal because of the slight setting expansion and low solubility. Leakage along root canal fillings may increase with time due to partial dissolution which was confirmed by Kontakiotis et al. (2). In many longitudinal studies, filling techniques or different sealers such as AH 26 and Sealapex (3), AH26, Ketac-Endo and Tubuli-Seal (4) and AH26 and AH Plus (5) were compared. Not only the technique or sealers, but the shape of the root canal is also important and studied (6). Most of the root canal sealers show some potential biohazard effect on the leaving tissue, at least during setting period. Calcium hydroxide and silicone based sealers are biocompatible (7,8) and due to this, the purpose of this study was to investigate the leakage of two different sealers, calcium hydroxide based Apexit Plus and silicone based GuttaFlow, after 24h of obturation as well as after the thermocycling process.

Materials and methods

Selection and instrumentation of teeth

Twenty-six single-rooted permanent teeth with fully developed roots were used. The teeth were obtained from the Department of Oral Surgery, School of Dental Medicine, University of Zagreb, and were stored in a 0.9% sodium-chloride solution (NaCl). Tooth crowns were removed at the cemento-enamel junction using a diamond drill. The samples were mechanically cleaned up with a round steel drill. The length of each root canal was established using K file size 15 (ISO # 15) (Maillefer, Ballaigues, Switzerland), letting the tip of the instrument pass through the apical foramen, and then the instrument was withdrawn for 1 mm. The length obtained was used as working length. The root canals were hand filed to a size #25 K file to the working length. All root canals were then instrumented to working length with ProTaper rotary files, size S1, S2, F1, F2, F3 (Dentsply, Maillefer) and Glyde root canal lubricant (Dentsply, Tulsa, OK). For root canal instrumentation, average rotation speed was 300 rpm. Each canal was irrigated with freshly prepared 2% NaOCl with a 27-gauge needle after every instrument. After preparation was completed, canals

nim NaOCl-om i iglom 27G. Nakon završene obrade u svaki je kanal bilo uneseno 5 mL 17-postotne EDTA (13). Nakon tri minute bili su isprani s dodatnih 5 mL 2-postotne otopine NaOCl-a (3), a zatim posušeni papirnatim štapićima veličine 30 (DiaDent, Koreja). Uzorci su nasumce bili podijeljeni u dvije skupine po 10 zuba, a šest se koristilo kao kontrolna skupina.

Punjenje korijenskih kanala

Skupina 1

Prva skupina uzoraka bila je napunjena gutaperka štapićima (VDW, Minhen, Njemačka) tehnikom hladne lateralne kondenzacije i punilom Apexit Plus. Glavni (engl: Master, MAP) gutaperkin štapić veličine 30, obložen punilom Apexit Plus bio je umetnut u kanal do pune radne dužine. Potiskivačem (engl: spreader) veličine 25 dodatno su lateralno potiskivani u kanalu gutaperkini štapići veličine #25. Postupak se ponavljao sve dok endodontski prostor nije bio potpuno napunjen. Zatim je višak gutaperke bio uklonjen vrućim nabijačem (engl: plugger), a ostatak gutaperke u kanalu na kraju je vertikalno kondenziran hladnim nabijačem (engl: plugger).

Skupina 2

Druga skupina uzoraka bila je napunjena punilom GuttaFlow. Glavni (MAP) gutaperkin štapić izabran je prema promjeru instrumenta (engl: Master apical file – MAF) te je punilo ubrizgano u osušeni kanal špricom s posebnim nastavcima. Zatim je, u tako napunjen, kanal bio postavljen glavni gutaperkin štapić do pune radne dužine te su dodana još dva ili tri štapića. Ostatak kanala napunjen je GuttaFlow punilom. Kada se punilo stvrdnulo, višak je uklonjen vrućim nabijačem.

Nakon punjenja, lateralne stijenke zuba bile su premazane s dva sloja izolacijskog laka koji se sušio 24 sata. Zatim je prijenosom tekućina izmjerena propusnost korijenskih kanala.

Pozitivna kontrolna skupina

Tri uzorka rabljena su kao pozitivna kontrola te su bili napunjeni gutaperkinim štapićima bez punila i izolacijskog laka.

Negativna kontrolna skupina

Tri uzorka koristila su se kao negativna kontrola i bili su napunjeni gutaperkinim štapićima i standardnim punilom AH Plus, a vanjske stijenke bile su premazane s dva sloja izolacijskog laka.

Konstrukcija prijenosa tekućine

Propusnost punjenja korijenskih kanala bila je izmjerena prijenosom tekućine dvadeset i četiri sa-

were rinsed with 5 mL 17% EDTA for 3 min to remove the smear layer (13). Finally, the canals were rinsed with an additional 5 mL 2% NaOCl solution (3). Each canal was dried using paper points size 30 (DiaDent, Korea). The samples were divided into 2 groups of 10 samples each. Six specimens were used as a control group.

Obturation of root canals

Group 1

The first group was obturated using the cold lateral condensation technique, with the gutta-percha points and Apexit Plus sealer. A size 30 gutta-percha master cone (MAP) (VDW, Munich, Germany) coated with Apexit Plus sealer was inserted into the canal to the full working length. Lateral condensation was achieved using a finger spreader size 25 and gutta-percha cones size 25. The procedure was repeated until there was complete endodontic obturation. The excess gutta-percha was removed by a hot plugger. The remaining gutta-percha in the root canal was vertically condensed with a plugger.

Group 2

The second group was filled with GuttaFlow sealer. The MAP of the size according to that of the MAF was chosen. GuttaFlow was inserted into the previously dried canal, using the dispenser and the prefabricated canal tips. When the root canal was filled, the gutta percha point (MAP) was inserted into it to its full working length with the addition of two or three points. The remaining part of the canal was filled with the GuttaFlow material from the canal tip. After the setting of material, the excess was removed using a hot plugger.

After the obturation procedure was finished lateral surfaces of the teeth were covered with 2-layered insulation varnish and dried for 24h. After that the leakage was evaluated using fluid transport model.

Positive control group

Three samples were used as positive control and filled with gutta-percha points without any sealer and without an insulating layer.

Negative control group

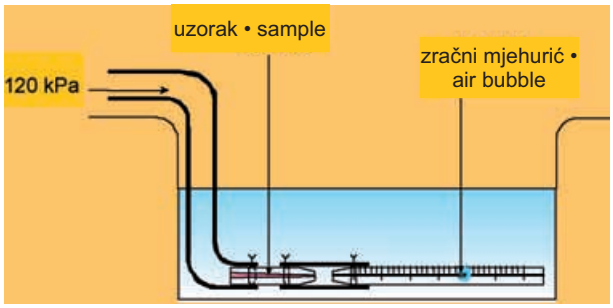
Three samples were used as negative control and filled with gutta-percha points with AH Plus as a standard sealer, with their outer root surfaces fully covered in 2-layered insulation varnish.

Fluid transport model

The leakage of root canal filling was evaluated using the fluid transport model (Figure 1) previous-

ta nakon unosa u korijenski kanal (Slika 1.), što su opisali Wu i suradnici (3). Pomak zračnih mjehurića u kapilarnoj cjevčici analiziran je pet minuta pod tlakom od 120 KPa. Rezultati su izraženi u mikrolitrama (μL). Za svaki su uzorak bila obavljena četiri mjerenja, a zatim je izračunata srednja vrijednost. Nakon toga su zubi termociklirani - 300 ciklusa na temperaturi između 5 i 55 °C (14) te je ponovno izmjerena propusnost punila.

ly described by Wu et al. (3). The shift of air bubbles in the capillary tube was observed in the course of 5 minutes under the pressure of 120 kPa. The results were expressed in microlitres (μL). On each sample 4 measurements were conducted from which the average value was calculated in microlitres. After the first measurement teeth were carefully disconnected from the assembly and thermocycled for 300 cycles at the temperature between 5 and 55 °C (14). After that, the leakage was re-measured.



Slika 1. Konstrukcija prijenosa tekućine.
Figure 1 Fluid transport model

Statistička analiza

Rezultati su obrađeni neparametrijskom statističkom metodom (ANOVA), budući da je preliminarna analiza (test Lavene) pokazala znatan nedostatak homogenosti odstupanja. Kruskal-Wallisova ANOVA rabljena je za usporedbu između skupina s punilom Apexit Plus i GuttaFlow, a za analizu razlike ovisnih uzoraka (isto punilo prije termocikliranja i nakon njega) korištena je Friedmanova ANOVA. Razina značajnosti bila je 0,05.

Statistical analysis

Results were statistically evaluated with the non-parametric analysis of variance (ANOVA), as the preliminary analysis showed significant lack of homogeneity of variances, as measured by Lavene's test. The comparison between the groups of Apexit Plus and GuttaFlow materials was performed using the Kruskal-Wallis ANOVA, while the analysis of differences of dependent samples (the usage of same obturation cement before and after the thermocycling) was performed using the Friedman ANOVA. The level of significance was set at 0.05.

Tablica 1. Srednje vrijednosti i standardna devijacija za ispitivane materijale
Table 1 Mean values and standard deviation for tested materials

	24 sata nakon punjenja • 24h after obturation	Nakon termocikliranja • After thermocycling
GuttaFlow	0,63+/-0,04	0,61+/-0,08
Apexit Plus	0,82+/-0,08	0,83+/-0,09

Rezultati

Rezultati istraživanja pokazali su statistički znatno manje propuštanje kanala punjenih punilom GuttaFlow u usporedbi s Apexit Plusom, odmah nakon punjenja i termocikliranja (obje usporedbe: Kruskal-Wallisova ANOVA, p=0,0002). Kod uzoraka punjenih Apexit Plusom razlika u propusnosti bila je statistički veća 24 sata nakon punjenja i termocikliranja (p=0,011), a kod uzoraka punjenih Gu-

Results

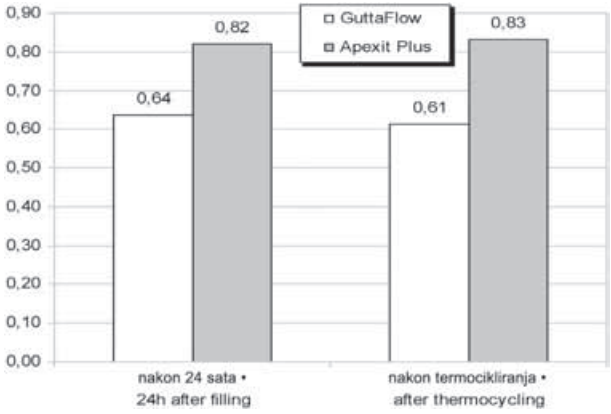
Statistically analyzed results of the research have shown that GuttaFlow obturated significantly better than Apexit Plus, both straight after the obturation procedure and after the thermocycling (both comparisons: Kruskal-Wallis ANOVA, p=0.0002). Furthermore, in samples obturated with Apexit Plus root canal sealer, there was a statistically significant difference in leakage 24h after the filling and after

ttaFlowom propusnost mjerena u istom vremenu statistički nije bila znatna (Friedmanova ANOVA, p=0,739). Rezultati propusnosti punila prikazani su u Tablici 1, Slika 2.

Kod negativne kontrole nije bio zabilježen prijenos tekućine, a u pozitivnoj kontroli kretanje mjehurića zraka bilo je prebrzo za mjerenje.

the thermocycling (p=0.011), which was insignificant for GuttaFlow (Friedman ANOVA, p=0.739). The results of the obturation leakage measurements are shown on Table 1, Figure 2.

In the negative controls, no fluid transport was recorded, whereas in the positive controls the air bubble moved too fast to be measured.



Slika 2. Rezultati propusnosti punjenja (24 sata nakon punjenja / nakon termocikliranja)
Figure 2 Filling leakage results (24h after the filling / after the thermocycling)

Rasprava

U ovom istraživanju ispitana je propusnost dvaju različitih punila korijenskih kanala – prvi je bio Apexit Plus na bazi kalcijeva hidroksida, a drugi silikonsko punilo GuttaFlow proizvedeno na temelju polidimetilsiloxana s dodatkom gutaperke u prahu. Rezultati su pokazali statistički znatnu razliku u propusnosti između Apexit Plusa i GuttaFlowa 24 sata nakon punjenja i umjetnog starenja uzoraka termocikliranjem. Moguće objašnjenje za to jest da Apexit Plus otpušta kalcijeve i hidroksilne ione, pa se materijal dezintegrira i cijepa njegova već stvrdnuta struktura. Rezultati su u skladu s rezultatima istraživanja Miletić i suradnika (13) u kojem je Apexit pokazao veće propuštanje u usporedbi s punilima AH26, AH Plus, Diaket i Ketac-Endo. Slični su i zaključci u istraživanju Wua i njegovih kolega (3) u kojemu je najveću propusnost pokazalo kalcijevo hidroksilno punilo Sealapex.

U ovom istraživanju koristila se u ispitivanju propusnosti konstrukcija za prijenos tekućine, a ne tehnika propuštanja boje budući da mjehurići zraka zaostali tijekom punjenja mogu ometati prodor boje (14). Konstrukcija prijenosa tekućine omogućuje da se uzorci sačuvaju te da se mjerenje propusnosti ponovi nakon termocikliranja ili određenog vremenskog razdoblja (14). Rezultati propusnosti materijala nakon određenog vremena važni su za kliničku primjenu, jer zbog njihova stalnog izlaganja tkiv-

Discussion

In this study the leakage of two root canal sealers was examined. The first material was Apexit Plus calcium-hydroxide based, and the second one, GuttaFlow, was sealer based on polydimetilsiloxane with the addition of powdered gutta-percha. The results showed a statistically significant difference between the leakage of Apexit Plus and GuttaFlow after the obturation process and after the artificial aging of samples with thermocycling. These results can be explained by the fact that Apexit Plus releases calcium and hydroxyl ions during a process in which the material disintegrates, leading to cleavage formation of once hardened material. These results agree with the results of Miletic et al. (13) in which Apexit showed inferior results compared to AH26, AH Plus, Diaket and Ketac-Endo. Similar results were obtained by Wu et al. (3) who determined the greatest leakage when Sealapex, which is also based on calcium hydroxide, was used as an endodontic obturation sealer.

In this study, the used construction for fluid transport was considered more appropriate for leakage measurement than the technique of dye penetration, because an air bubble left during the filling could obstruct the dye penetration (14). Also, with this research technique, the samples were not destroyed, so that the measurement could be repeated over again after the thermocycling or after a certain period of time (14). For the clinical application

nim tekućinama i nepotpunog brtvljenja korijenskih kanala, endodontski tretman može završiti neuspjehom (11,12). Ni jedna tehnika ne uključuje sve parametre usne šupljine i zato je za konačni zaključak potrebna dodatna procjena.

U studiji Buillagueta i suradnika (15), GuttaFlow je bolje brtvio u usporedbi s AH Plusom i gutaperkinim štapićima. U većini je radova AH Plus pokazao propusnost, ali to je punilo u ovom istraživanju bilo rabljeno kao standardno u negativnoj kontrolnoj skupini. Apeksni otvori svih uzoraka bili su prekriveni dvama slojevima laka, sprječavajući na taj način apikalno propuštanje. Ti negativni rezultati propusnosti negativne kontrolne skupine omogućuju usporedbu rezultata drugih skupina.

Zaključak

Rezultati istraživanja pokazali su razliku u propusnosti između punila Apexit Plus i GuttaFlow. U oba mjerenja GutaFlow je manje propuštao od Apexit Plusa. Kod uzoraka punjenih GutttaFlowom nije bilo statistički znatne razlike u propusnosti prije termocikliranja i nakon njega. Kod uzoraka punjenih Apexit Plusom propusnost prije termocikliranja i nakon toga postupka bila je statistički znatna, s većim prosječnim vrijednostima propusnosti nakon termociliranja.

of material, the results of leakage after a certain period of time are important because of the constant exposure of the material to tissue fluid, and if not properly obturated, it could lead to an unsuccessful endodontic treatment (11,12). None of the research techniques includes all the parameters from the oral cavity, and additional assessment must be conducted in order to make the final conclusion.

In addition, study made by Buillaguet et al. (15) has shown superior sealing ability of GuttaFlow compared to AH Plus and guttta-percha technique. In addition, most of the studies where AH Plus was used showed leakage however as a negative control group in our study, the apex orifice of the samples was covered by two layers of nail polish preventing the apical leakage. Thus the negative leakage results of the control group allowed us to compare the results of other groups.

Conclusions

The results of this research show that there was a difference in leakage between Apexit Plus and GuttaFlow sealers. In GuttaFlow samples there was no statistically significant difference between results measured before and after the thermocycling. However, in the samples obturated with Apexit Plus material, there was a statistically significant difference in leakage before and after the thermocycling because of greater average results of leakage after the thermocycling.

Abstract

Objectives: To compare the leakage of two root canal sealers, Apexit Plus and GuttaFlow. **Materials and Methods:** For the purpose of the research, 26 single-rooted extracted permanent teeth were used. Root canals of all the samples were prepared using ProTaper rotary files. Teeth prepared and instrumented were divided into two groups of 10 teeth. The first group was obturated using the technique of cold lateral condensation, with the use of gutta-percha points and Apexit Plus sealer. The second group was obturated with the GuttaFlow. Six samples were used as a control group. The leakage of root canal filling on samples was examined by the use of fluid-transport model, 24h after the obturation and thermocycling. **Results and Conclusion:** Statistically analyzed results of the research have shown that GuttaFlow obturated significantly better than Apexit Plus 24h after the obturation procedure and after the thermocycling (both comparisons: Kruskal-Wallis ANOVA, $p<0,0002$). In samples obturated with Apexit Plus root canal sealer, there was a statistically significant difference in leakage 24h after the filling and after the thermocycling ($p=0.011$), which was insignificant for GuttaFlow (Friedman ANOVA, $p=0.739$). Under the conditions of this study, GuttaFlow provided a better seal than Apexit Plus.

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Key words
GuttaFlow; Apexit Plus; Fluid Transport Model; Dental Pulp Cavity; Root Canal Filling Materials

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