Procjena mikropropuštanja između različitih sustava kolčića i nadogradnji u uvjetima postupnog opterećenja: istraživanje in vitro

**Evaluation of Microleakage Between Different Post and Core Systems Under Microscopic Loading: an In-Vitro Study**

**Sažetak**

**Svrsna**: Istraživanje je usmjereno na usporedbu u razlici spojnog prodora boja između svijetlovodnih kolčića everStick, Parapost XP i Parapost i kontrolnih skupina pod postupnim opterećenjem. **Materiali i metode**: Sedamdeset osam ljudskih maksilarnih trajnih sjekutića podijeljeno je u četiri skupine. Svaki uzorak endodontski je tretiran tehnikom instrumentacije i pripremljen za svaki sustav kolčića prema eksperimentalnim skupinama. Nakon toga kolčić je cementiran u korijenski kanal. Obljubljene nadogradnje od kompozitnog materijala cementirane su u laboratorijski izrađene metalne krunice. Svi su uzorci termocikliirani, osim onih u kontrolnoj skupini. Sve su skupine podvrgnute postupnom opterećenju od 0 N do 50 N u 100 ciklusa. Uzorci su poprečno prijelazarni i izmjerene su dubine prodora boje. Svi uzorci su usenjani u SPSS ver. 22 i analizirani dvosmjernim testom ANOVA. Rezultati: Nije bilo značajne razlike u spojnom prodoru boje u svima skupina (p – vrijednost > 0,05). No zabilježena je značajna razlika u postotku prodora boje između svih skupina (p – vrijednost < 0,05); post-hoc usporedba pokazala je značanje razliku između Fiber White skupine i one kontrolne (p – vrijednost = 0,009). **Zaključak**: U svim je skupinama u uzorke prodirala boja, ali postotak je bio značajan samo između Parapost Fiber Whitea i kontrolnih skupina.

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**Ključne riječi**

endodoncija; kolčić-nadogradnja tehnik-a; vlaknima ojačani polimeri; rubber prijelaznik; dentalno propuštanje
puštanja između sustava i zuba, kao o znacajnom pokazatelju uspjeha konačne restauracije (9).

Mikropropuštanje se opisuje kao difuziju bakterija, oralnih tekućina, ionala i molekula u zub i između materijala za punjenje korijenskih kanala ili klinički nevidljive prolazak bakterija, tekućina, molekula ili ionala između zuba i restaurativnog materijala ili punila korijenskog kanala (15). Apikalna brzina od 3 do 5 mm korijenskog punjenja kanala opisana je kao upitna u smislu sprječavanja mikrocurenja (12).

Zamor materijala koji se događa u strukturama podvrgnutima dinamičkom stresu navodi se kao uzrok mikropropuštanja. Taj se čimbenik mora uzeti u obzir jer mikropropuštanje može poslije uzrokovati sekundarni karijes koji negativno utječe na stopu preživljavanja zuba i uzrokuje uspjeh u liječenju (3). U jednom drugom istraživanju ističe se da bakterije i endotoksini imaju svojstvo prodiranja u materijal za punjenje u liječenim korijenskim kanalima (13). Prodor bakterijskih toksina, oralnih tekućina i drugih iona izaziva rubnu obojenost, sekundarni karijes i granične frakture. Mikropropuštanje je najčešći uzrok uspjeha kad je riječ o sustavima količića i nadogradnje, zbog odvajanja količića od unutarnje površine koričenja (9). Taj gubitak retencije između količića i koričena može rezultirati vertikalnom frakturama korijena i to je najožbiljniji uzrok uspjeha s nepovratnim posljedicama (16).

Istraživanje Junga i suradnika (2007.) pokazalo je testom prodora boje da postoji razlika u količini mikropropuštanja između skupina, a obavljeno je test dinamičkog opterećenja i tijekom opetovanog opterećenja. U skupini s opetovanim opterećenjem nije uspjela adhezivna veza između struktura zuba i jezgara jer je boja prodrla u veće područje korijenskog dentina. Fogel (1995.) je procijenio nekoliko tvorničkih post-core sustava testom mikropropuštanja filtracije fluida i uspostavio da se nj jednim od ispitanih sustava ne može poticati potpuno nepropusno brtvljenje. Nekada su mogućnosti za količić i nadogradnje bile ograničene pa je lijevana metalna nadogradnja bila jedini izbor za restaurativno liječenje teško oštećenih zuba (17). Trenutačno se postoje različiti sustavi koja se koriste kao alternativa za izradu posta, Parapost XP, Parapost Fiber White) i kontrolnih skupina.

Materijali i metode

Istraživanje je obavljeno u Maksilofacijalnom laboratorijskom Stomatološkog fakulteta Sveučilišta Sains u Maleziji (USM). Veličina uzorka izračunata je korištenjem PS software (Dupont i Plummer, 1997) na temelju standardne devijacije (σ) prosječnog gama-broja na 7,33 (8) s 80% snage i alfa od 0,05. U svakoj skupini bilo je petnaest zuba. Uz pretpostavku da bi 10% uzorača iz svake skupine moglo biti problematično tijekom postupka, bilo je 17 zuba u svakoj, što je ukupno 68 zuba u cijelom istraživanju. Svi zubi dobiveni su u državnim i privatnim stomatološkim klinicama u Maleziji.

leakage between the system and the tooth was crucial for the success of the final restoration (9).

Microleakage is defined as the “diffusion of the bacteria, oral fluids, ions and molecules into the tooth and the filling material interface” or “the clinically undetectable passage of bacteria, fluids, molecules or ions between tooth and the restorative or filling material” (15). The presence of 3 to 5mm apical seal was reported to be “questionable” in terms of preventing microleakage (12).

Fatigue that happens in the structures subjected to dynamic stress was reported to cause microleakage clinically. This factor needs to be considered as microleakage will later cause secondary caries formation that will affect the survival rate and cause failure of the treatment itself (3). Other study reported that bacteria and endotoxins had the ability to penetrate the obturating materials in the post prepared root canals (13). The penetration of bacterial toxins, oral fluids, and other ions will lead to marginal discoloration, secondary caries and marginal fractures. Microleakage had been reported to be the most frequent cause of failure for the post and core system because of the separation of the post from the internal root surface (9). This loss of retention between the post and the root may lead to vertical root fracture, which was the most severe cause of failure with irreversible consequences (16).

A study by Jung et al. (2007) found that there was a difference in the amount of microleakage between group with the dye penetration test performed after dynamic loading and during the repeated loading. The group with repeated loading showed the adhesive failure between the tooth structure and the core where the dye penetrated into a larger area of root dentin. Fogel (1995) evaluated several prefabricated post and core systems with fluid filtration microleakage test and found that none of the systems tested were capable of consistently achieving fluid-tight seal.

In the past, the options for post and core were limited and cast metal post was the only practicable choice for the restorative treatment of severely damaged teeth (17). At present, there was lack of evidence with regard to superiority of the post and core systems related to microleakage under gradual loading. Thus, the aim of this experimental research was to compare the difference in marginal dye penetration between three types of posts under gradual loadings (everStick post, Parapost XP, Parapost Fiber White) and control groups.

Materials and methods

The study was conducted at Craniofacial Laboratory of the School of Dental Sciences, Health Campus University Sains Malaysia (USM). The sample size was calculated using PS software (Dupont and Plummer, 1997) based on the standard deviation (σ) of the mean gamma count at 7.33 (8) with 80% power and alpha of 0.05. Fifteen teeth were needed in each study group. With anticipation of 10% of the samples from each group which could pose problems during the procedure, 17 teeth were included in each group, to make a total of 68 teeth in this study. All teeth were collected from government and private dental clinics in Peninsular Malaysia.
Korišteni su trajni maksilarni sjekutici s jednim ravnim korijenskim kanalom, bez karijsnih lezija ili zubi s karijesom bez zahvaćenih pulp te ograničeni na 2 mm inicizalno od cementno-caklinskog spoja (CEJ) s formiranim apekslom ili zubi izvadeni zbog parodontne indikacije i oni bez napuklina i defekata. Kriteriji za isključivanje uključivali su zube s dodatnim korijenskim kanalom, otvorenim apekslom, kalcificiranim kanalom, zakrivljenim korijenijama i korijenijama s vanjskom resorpcijom. Količići korišteni u istraživanju prikazani su u tablici 1. Za cementiranje količića i krunica u ovoj studiji upotrijebljen je cement Rely X U200 (3M ESPE, SAD).

**Priprema uzoraka**

**Priprema korijenskog kanala**

Sve vanjske strugotine uklonjene su ul.brazučnim skalerom, a zubi su odloženi u fiziološku otopinu. Kruna zuba je uklonjena okomito na uzdužnu osnovu zuba dijarnatnim fisurnim svrdlom uz vodo hlađenje (Horico, Njemačka) ručno-zračnom turbinom (Bien Air Dental SA, Švicarska), ostavljajući samo 2 mm koronalnog dijela inicizalno na cemento-caklinskom spoju (CEJ) bukalne površine.

Ravan ulazak u koronalnu trećinu kanala postignut je dijarnatnim fisurnim svrdlom uz vodo hlađenje (Horico, Njemačka) ručno-zračnom turbionom (Bien Air Dental SA, Švicarska). Svi korijenski kanali instrumentirani su na radnoj duljini tehnikom Step Backa. Radna duljina zuba dobivena je u kanalu instrumentom broj 10 sve dok se nije pojavio na vrhu korijena, a zatim se od izmjerene duljine oduzelo 0,5 mm. Irrigacija je obavljena 2,5-postotnim natrijevim hipokloritetom, naizmjenično je isprana hiziološkom otopinom između obrade različitim veličinama instrumenta, a kanali su posušeni papirnatim šiljcem.

Kanali su instrumentirani Master Apical Fileom veličine 45 za Parapost XP, Parapost Fiber White i kontrolne skupine, a za everStick je veličina MASTER Apical Filea bila 55. Priprema kanala za sve skupine nastavljena je korištenjem triju instrumenta s većim promjerima, uz oduzimanje 1 mm između svakog instrumenta. Korijenski kanal napunjena je guaperkom (Meta Biomed, Žužina Koreja) i AH26 bez eugenola (Dentsply, SAD). Radiogram je snimljena za svaki uzorak kako bi se osiguralo da je zub napunjeno u kanalu, a 24 sata poslije početka instrumentacije, u skupinama Parapost XP, Parapost Fiber White i everStick guaperka je iz kanala uklonjena svrdlima Gates Glidden (Dentsply, Švicarska) veličine 2 i 3, a ostavljeno je samo 5 mm na vrhu korijena za apikalnu brvat.

Prostori za količići pripremljeni su za svaki sustav odgovarajućim svrdlima Parapost XP i Parapost Fiber White.

**Specimens Preparation**

**Root canal preparation**

All external debris was removed with an ultrasonic scaler and the teeth were stored in normal saline solution. The coronal section of the teeth were amputated horizontally to the long axis using water cooled diamond fissure bur (Horico, Germany) in air turbine handpiece (Bien Air Dental SA, Switzerland), leaving only 2mm of the coronal part incisal to the cementoenamel junction (CEJ) from the buccal surface.

Straight-line access into the coronal third of the canal was made using water cold diamond fissure bur (Horico, Germany) in air turbine handpiece (Bien Air Dental SA, Switzerland). All root canals were instrumented at a working length using the step-back technique. The working length of the teeth was obtained by inserting number 10 file into the canal until it appeared at the apex of the root, then 0.5mm was subtracted from the total length. Intermittent irrigation was made with 2.5% sodium hypochlorite, rinsed with saline solution between file sizes and the canals were dried with paper points. The canals were prepared until Master Apical File size of 45 for Parapost XP, Parapost fiber white and control groups, whereas for everStick group the Master Apical File the size was 55. The canal preparation for all groups was continued using 3 sizes of larger files with subtraction of 1 mm between each file. Obturation was done using the gutta percha (Meta Biomed, South Korea) and AH26 eugenol free sealer (Dentsply, USA). A radiograph was taken for each specimen to ensure there was no air bubbles present in the canal. After 24 hours of the initial preparation, the gutta percha points in Parapost XP, Parapost fiber white and everStick groups were removed using Gates Glidden (Dentsply, Switzerland) size 2 and size 3 leaving only 5mm at the apex of the root as an apical seal.

The post spaces were prepared for each system with Parapost XP drill and Parapost Fiber White (PF160) drill (Coltane Whaledent, USA). Post space preparation for ever-
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Cementation of all types of posts was performed using self-adhesive resin luting cement (Rely U X200, USA). The resin cement application was based on the manufacturer’s guidelines.

For the control group, no post space preparation was carried out. The core was prepared with 2mm of sound tooth structure, which was included at the margin of the preparation.

Crown Fabrication
A core built up for each specimen was done using composite resin (Filtek™ Z350 XT, USA). The horizontal surfaces of the coronal area of each specimen were firstly etched using 32% phosphoric acid (Scotchbond™ Universal Etchant, USA) for 15 seconds and then washed and dried using triplex syringe. Each tooth was continued with application of bonding agent (3M ESPE Adper Single Bond Plus, USA) and etched 10 seconds, in order to standardize the size and length of the post where the post lengths used were three-quarters of the total root length for each specimen, and the post size was smaller than one-third of the root diameter or as close as possible to this value. The procedure based on report from Le Bell-Rönnlöf et al. (2011) was applied to the everStick group. The bundle fibers of 1.2mm were fitted in the canal, both end were cut to fit leaving 2mm of fiber incisal to the coronal opening. The fibers were then light-polymerized using a light curing device for 40 seconds (Mini L.E.D OME, France). Next, the fibers were removed and light-cured again outside the canal for another 40 seconds. After that, the additional bundles were fitted next to and attached to the individually formed 1.2mm bundle until the posts were properly fitted in the canal and light cured. The fitting of the posts inside the canals was confirmed with a radiograph. Cementations of all types of posts were performed using self-adhesive resin luting cement (Rely UX200, USA).

Material Testing
Each specimen was coated with 3 layers of commercial nail varnish from the apex to the CEJ level to prevent microleakage at the apex. All groups were subjected to thermal cycling of 2000 cycles in 5°C-55°C water bath with a dwell time of 20 seconds in each bath. The everStick post, Parapost XP, Parapost fiber white groups were positioned at 135 degrees to the long axis of the tooth and were loaded for gradual loading from 0N to 50N for 100 cycles (Instron, United Kingdom) (20). The gradual loading test was not performed for the control group.

Marginal leakage testing
After the loading, the everStick post, Parapost XP, Parapost fiber white and the control group were immersed in 2%
metilenski plavu boju tijekom 24 sata na sobnoj temperaturi (21) zatim su isprani tekućom vodom da se ukloni suvišak boje. Svi su zubi prerezani transverzalno od spoja nadogradnje i zuba prema apektu (Exact, Njemačka) te promatrani stereomikroskopom pod povećanjem od 30 puta (Leica, Njemačka). Deskriptivna mjerenja obavljena su na temelju fotografija prerezanih zuba na kojima je mjerenja prisutnost i/ili dubina prodora boje, uz preparaciju za količić u milimetrima. Izračunat je omjer prodora boje u odnosu prema cijelom presjeku i zabilježen dobiveni postotak.

Statistička analiza

Za statističku analizu podataka korišten program Statistical Package for the IBM Social Sciences (SPSS) version 22.0. Za parametrijsku analizu odabran je Kruskal-Wallisov test sa svrhom određivanja i uspoređbe srednje vrijednosti dubine prodiranja boje između skupina everStick, parapost XP, parapost Fiber White i kontrolne, a dvosmjerna ANOVA primijenjena za određivanje i usporedbu postotka prodora boje u te skupine. Srednja vrijednost testirana je za značajnost s pomoću p-vrijednosti i višestrukom usporedbom post-hoc testa (Scheffeova). Vrijednost p postavljena je na razinu značajnosti p < 0,05.

Etičko dopuštenje

Istraživanje je odobrilo Etičko povjerenstvo za znanstvena i etička pitanja USM-a (USM/JPEM/15080267).

Rezultati

Prodor boje na rubnim dijelovima za svaki uzorak u svakoj skupini analiziran Kurskal-Wallisovim testom pokazao je da nema statistički značajne razlike među skupinama (p - vrijednost = 0,193).

Medijan s međukvartilnim rasponom za svaku skupinu već je naveden i nalazi se u tablici 2. Pokazuje da skupina everStick ima najveći medijan, a skupina Parapost Fiber White najmanji. Dvosmjerna ANOVA korištena je za analizu postotka prodora boje između everSticka, Paraposta XP, Parapost Fiber Whitea te kontrolnih skupina. Kao što se vidi u tablici 3, nije bilo značajne razlike u aritmetičkim sredinama postotaka prodora boje među skupinama uz p-vrijednost = 0, 009 i F-statističku vrijednost od 4,194 sa stupnjem slobode od 3. Aritmetička sredina i standardna devijacija za svaku skupinu methylene blue dye for 24 hours at room temperature (21) followed by rinsing with tap water to remove excess dye. All teeth were sectioned transversely from the tooth core interface towards the apex (Exact, Germany) and observed under 30x magnification stereomicroscope (Leica, Germany). Descriptive measurements were made from the photograph of the sectioned tooth followed by measuring the depth of dye penetration along the post preparation area in mm in order to obtain the sign and depth of the leakage. Ratios of dye penetration to entire section of the roots were measured and dye penetration percentages were recorded.

Statistical Analysis

Statistical Package for the IBM Social Sciences (SPSS) version 22.0 was used for data entry. Non parametric analysis using Kruskal-Wallis test was performed to determine and compare the mean depth of dye penetration between everStick, parapost XP, parapost fiber white and control groups while a two-way ANOVA was performed to determine and compare the percentage of dye penetration these groups. The mean score with significant P-value was tested using multiple comparison Post-hoc tests (Scheffe’s procedure). The p-value was set as significant at p<0.05.

Ethical clearance

Ethical clearance was obtained from USM research and approval was obtained from the Ethics Committee (USM/JPEM/15080267).

Results

The dye penetration at the marginal area for each specimen in each group was analyzed using Kruskal-Wallis and the result showed there was no significance of the median between the groups (p-value =0.193). The median with in-quartile range for each group was as stated in Table 2. It showed that everStick group had the highest median while Parapost fiber white group had the lowest median.

A two-way ANOVA was used to analyze the percentage of dye penetration between everStick, Parapost XP, Parapost Fiber white, and control groups. As shown in Table 3, there was a significant difference of the mean of the percentage of dye penetration between the groups with p-value of = 0.009 and the F-statistic value was 4.194 with degree of freedom (df) 3. The mean and standard deviations for each group were as shown in Table 3. The highest mean was presented in the

Tablica 2. Usporedba medijana dubine prodora boje između everSticka, Paraposta XP, Parapost Fiber Whitea i kontrolnih skupina

Table 2 Comparison of median depth of dye penetration between everStick, Parapost XP, Parapost Fiber white and control groups.

| Skupina • Group | Prodor boje na rubu • Dye penetration at the margin (μm) | Medijan • Median (IQR) | p-vrijednost • p-value* |
|-----------------|-----------------------------------------------|------------------------|------------------------|
| Parapost XP     | 1884.23 (1477.360)                            | 0.193                  |
| Parapost Fiber White (PF160) | 892.43 (1816.050)                           |                        |
| everStick       | 2018.01 (1746.130)                            |                        |
| Control         | 1919.14 (573.560)                             |                        |

* Kruskal-Wallis test
nalaze se u tablici 3. Najviša srednja vrijednost dobivena je u kontrolnoj skupini, a Parapost Fiber White pokazao je najnižu aritmetičku sredinu.

Na temelju dobivenih rezultata, u dva uzorka u skupini everStick boja je prodrla do područja korijenskog kanala (60,63 % i 42,81 %). Bilo je prodiranja boje između everSticka, Parapost XP, Parapost Fiber Whitea i kontrolnih skupina.

post-hoc pokazuje značajnu razliku između Fiber Whitea, Paraposta i kontrolnih skupina post and Control group.

**Rasprava**

U ovom istraživanju nije bilo značajne razlike u dubini prodiranja boje između everSticka, Paraposta XP, Parapost Fiber Whitea i kontrolnih skupina. Ti rezultati mogu biti pod utjecajem zdrave strukture zuba od 2 mm koja je djelovala kao ferula za svaki uzorak, što je rezultiralo izostajanjem razlika. Predloženo je da ferula, kao dio kolčića i nadogradnje, kao ferula za svaki uzorak, što je rezultiralo izostajanjem razlika. Predloženo je da ferula, kao dio kolčića i nadogradnje, kao ferula za svaki uzorak, što je rezultiralo izostajanjem razlika. Predloženo je da ferula, kao dio kolčića i nadogradnje, kao ferula za svaki uzorak, što je rezultiralo izostajanjem razlika.

**Table 3.** Usporedba srednje vrijednosti prodora boje između everSticka, Paraposta XP, Parapost Fiber Whitea i kontrolnih skupina. Comparison of mean percentage of dye penetration between everStick, Parapost XP, Parapost Fiber White and control groups.

| Skupina • Group   | Postotak prodora boje na rubu • Percentage of Dye Penetration at Margin | Aritmetička sredina • Mean (SD) | F-stat (df) | p-vrijednost • p-value |
|-------------------|--------------------------------------------------------------------------------|--------------------------------|-------------|------------------------|
| Parapost XP       | 82.97 (48.793)                                                               |                                |             |                        |
| Parapost Fiber White (PF160) | 49.87 (38.514)                                                                   |                                |             |                        |
| everStick         | 84.71 (28.310)                                                               |                                |             |                        |
| Control           | 94.68 (19.173)                                                               |                                |             |                        |

**Discussion**

There were no significant differences in depth of dye penetration between everStick, Parapost XP, Parapost Fiber White, and control groups in this study. These results may be influenced by the presence of 2mm sound tooth structure that acted as a ferrule for each specimen, thus resulting in no difference in the outcome. It had been suggested that the presence of ferrule as part of post and core system would resist functional lever forces and the wedging effect of tapered post (4). The presence of at least 1.5mm ferrule in single rooted teeth was reported to have better resistance to failure. Ferrule provides less impact to the post and core system, luting cements and the final restorations (22). This finding was similar to a study by Libman and Nicholls (1995) where the presence of 1,5-2mm ferrules provides better resistance to failure.

The everStick group showed the highest median depth of dye penetration compared to other groups in this study. This result may be influenced by the properties of the everStick material itself. The material itself has sticky behavior in a polymerized state and the fibers have a tendency to separate (24). These factors may cause contamination and alteration to the material itself that prevent the formation of a monoblock with the dentine (25). Another factor that leads to deeper leakage in the everStick group may also be the effect of polymerization shrinkage. As everStick was cured after it was adapted into the canal, polymerization shrinkage may have caused gap formation between the post and the dentinal wall (11). This may have caused the separation of cement when introduced to gradual loading in this study.

Torbjörner et al. (1996) reported that degradation and hydrolysis of the organic matrix occurred in fiber reinforced...
jačanog vlaknama (FRC) kao o reakciji na utjecaj vlage i smolastog materijala u FRC materijalu. Sama reakcija potaknula je bubrenje matriksa i posljedično odvajanje adhezivne veze i/ili pucanje na površini vlakana. To povećava apsorpciju vođe u FRC količićima i istodobno smanjuje njihova mehanička svojstva. Povećanje udjela vlakana u polimernoj matrici značajno povećava otpornost na frakturu, krotost i otpornost na zamor materijala količića (27). To može objasniti zašto je Parapost Fiber White post imao manje mikropropuštanja u usporedbi s količićima everSticka.

Savitljivost količića vrlo je važna u raspodjeli opterećenja i preživljavanju zuba restauriranog količićem i nadogradnjom. Naši rezultati ipak su u suprotnosti s onima iz istraživanja Lassila i suradnika (2004.) – njihovi rezultati testa trostrukog savijanja pokazali su da je everStick najčvršći u odnosu prema drugim FRC količićima koji su uključivali i Parapost Fiber White. Takvi rezultati mogu se pripisati razlici u polimernoj matrici everStick količića u kojoj nema lanaca polimetill-metakrilata (PMMA) koji mogu plastificirati križnu vezu s matriksom na temelju bisfenol-glicidil-metakrilata (bis-GMA), što smanjuje napetosti na spoju vlakana i matriksa tijekom savijanja.

Ustanovili smo da Parapost XP ima manji obujam mikropropuštanja u usporedbi sa skupinom everStick, što je u suglasju s Reidom i suradnicima (2003.). Oni su izvijestili da je nemetalna skupina imala značajno povećanje u mikropropuštanju u usporedbi s metalnim skupinama zbog postupka termocikliranja. To se može dogoditi zbog degradacije polimera koji drži vlakna na okupu i/ili samih vlakana jer su podložna stresu tijekom termocikliranja (2). No nema dokaza o razlici pri usporedbi čvrstoće savijanja različitih vrsta količića i proizvođača.

Na temelju dvosmjerne analize ANOVA-e nije bilo značajne razlike u postotku prozora boje između skupina, a post-hoc test pokazao je značajnu razliku između Parapost Fiber Whitea i kontrolnih skupina. Rezultati su pokazali da je u skupinama u kojima su korišteni količići i nadogradnja prodrobo boje bili manji u usporedbi s onima u kojima su zubi restaurirani bez količića. Da bi se pojačao endodontski liječen zub, koristi se sustav kolčića vrlo je važna u raspodjeli opterećenja i preživljavanju zuba restauriranog količićem i nadogradnjom. Prema drugim FRC količićima koji su uključivali i Parapost Fiber White, takvi rezultati mogu se pripisati razlici u polimernoj matrici everStick količića u kojoj nema lanaca polimetill-metakrilata (PMMA) koji mogu plastificirati križnu vezu s matriksom na temelju bisfenol-glicidil-metakrilata (bis-GMA), što smanjuje napetosti na spoju vlakana i matriksa tijekom savijanja. Ovo istraživanje provedeno je uz postupno opterećenje, kao alternativa cikličkom opterećenju. Cikličko opterećenje uzrokuje savijanje količića i odvajanje adhezivnog sloja između zubne strukture i količića i/ili nadogradnje (3), što objašnjava zašto je u neke naše uzorke u svakoj skupini boja prodirala do korijskog kanala. Na temelju istraživanja Naumann i suradnika (2005.), postupno opterećenje daje klinički relevantne informacije. Postupno opterećenje koje je korišteno u ovom istraživanju jest modificacija modela testiranja ko- jija je prikazan kao simulacija žvakanja i linearnog kompresivnog opterećenja. Ta prilagodba omogućila nam je da obavimo testiranje materijala na endodontski liječenim zubima uz uštedu vremena i novca. Linearno kompresivno opterećenje composite (FRC) post kao reakcija na kontakt među materialom i FRC samim materijalom. Reakcija izazvanoj matrici na spoj, krotost i otpornost na zamor materijala količića (27). Ovo može objasniti zašto je u ovom istraživanju javlja se reakcija na utjecaj vlage i smolastog materijala u FRC materijalu. Sama reakcija potaknula je bubrenje matriksa i posljedično odvajanje adhezivne veze i/ili pucanje na površini vlakana. To povećava apsorpciju vođe u FRC količićima i istodobno smanjuje njihova mehanička svojstva. Povećanje udjela vlakana u polimernoj matrici značajno povećava otpornost na frakturu, krotost i otpornost na zamor materijala količića (27). Ovo može objasniti zašto je Parapost Fiber White post imao manje mikropropuštanja u usporedbi s količićima everSticka.

Savitljivost količića vrlo je važna u raspodjeli opterećenja i preživljavanju zuba restauriranog količićem i nadogradnjom. Naši rezultati ipak su u suprotnosti s onima iz istraživanja Lassila i suradnika (2004.) – njihovi rezultati testa trostrukog savijanja pokazali su da je everStick najčvršći u odnosu prema drugim FRC količićima koji su uključivali i Parapost Fiber White. Takvi rezultati mogu se pripisati razlici u polimernoj matrici everStick količića u kojoj nema lanaca polimetill-metakrilata (PMMA) koji mogu plastificirati križnu vezu s matriksom na temelju bisfenol-glicidil-metakrilata (bis-GMA), što smanjuje napetosti na spoju vlakana i matriksa tijekom savijanja. Ovo istraživanje provedeno je uz postupno opterećenje, kao alternativa cikličkom opterećenju. Cikličko opterećenje uzrokuje savijanje količića i odvajanje adhezivnog sloja između zubne strukture i količića i/ili nadogradnje (3), što objašnjava zašto je u neke naše uzorke u svakoj skupini boja prodirala do korijskog kanala. Na temelju istraživanja Naumann i suradnika (2005.), postupno opterećenje daje klinički relevantne informacije. Postupno opterećenje koje je korišteno u ovom istraživanju jest modificacija modela testiranja kojiji je prikazan kao simulacija žvakanja i linearnog kompresivnog opterećenja. Ta prilagodba omogućila nam je da obavimo testiranje materijala na endodontski liječenim zubima uz uštedu vremena i novca. Linearno kompresivno opterećenje...
je nepovoljnije za testiranje kolčića i nadogradnji jer može rezultirati nejednakim kapacitetom opterećenja koje se ne pojavljuje u dinamičkim metodama. Iz tih razloga je, prema preporukama, u ovom istraživanju korišteno postupno opterećenje.

Premda postupno opterećenje može dati klinički relevantne rezultate, bilo bi točnije kad bi se testiranje materijala obavilo pod simulacijom žvakanja, jer bi se tada bolje mogla oponašati stvarna raspodjela okluzalnih sila.

Zaključak

Nije bilo značajne razlike u mikropropuštanju između everSticka, Paraposta XP, Parapost Fiber Whitea i kontrolnih skupina. Postotak marginalnog prodora boje bio je značajan između Parapost Fiber Whitea i kontrolnih skupina.

Sukob interesa

Autori nisu bili u sukobu interesa.

Zahvale

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Abstract

Objective: This study aimed to compare the difference in marginal dye penetration between everStick, Parapost XP, Parapost fiber white and control groups under gradual loading. Materials and Methods: Sixty-eight human maxillary permanent incisors were divided into four groups. Each specimen was endodontically treated with step-back technique and prepared for each post system according to experimental groups, subsequently cemented in the canal. Composite resin cores were built and laboratory fabricated metal crowns were cemented. All specimens except those in the control group were subjected to thermal cycling. All groups were subjected to gradual loading from 0N-50N for 100 cycles. Specimens were sectioned transversely and the depths of dye penetration along the post were measured. Data were entered in SPSS ver. 22 and analyzed using two-way ANOVA test. Results: There was no significant difference in marginal dye penetration between each group (p-value=0.05). However, there was a significant difference in percentage of marginal dye penetration between all groups (p-value=0.05); post-hoc comparison showed significant difference between Fiber White and Control groups (p-value=0.009). Conclusion: All the groups showed dye penetration but the percentage was significant only between Parapost Fiber White and the control groups.

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Conclusion

There was no difference in microleakage between everStick, Parapost XP, Parapost fiber white and control groups. The percentage of marginal dye penetration was significant between Parapost fiber white and the control groups.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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