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IZVORNI ZNANSTVENI RAD
*ORIGINAL SCIENTIFIC PAPER*

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# Intrakanalna prilagodba kolčića ojačanih vlaknima u odnosu na lijevane nadogradnje

# *Intracanal Adaptation of a Fiber Reinforced Post System as Compared to a Cast Post-and-Core*

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**Sažetak**

**Svrha istraživanja:** Namjera je bila usporediti prilagodbu kompozitnih intrakanalnih kolčića ojačanih vlaknima i lijevanih nadogradnji. **Materijal i metode:** Sedamnaest izvađenih ljudskih trajnih gornjih središnjih sjekutića endodontski je izliječeno prema standardnom protokolu. Sedamnaest kompozitnih intrakanalnih kolčića ojačanih vlaknima prilagođeno je prepariranim paralelnim korijenskim kanalima. Nisko viskozni vinil-polisiloksan (EXAMIX NDS, Japan) za otiske unesen je u korijenski kanal nakon kolčića. Digitalnom vagom izmjerena je masa preostalog materijala koji je ispunjavao prazninu između kolčića i unutarnje stijenke kanala. Prilagodba je određena na temelju razlika u masi prije unošenja otisnog materijala i nakon toga postupka. To isto ponovljeno je sa 17 lijevanih nadogradnji na istim zubima kao uzorcima. **Rezultati:** Srednja razlika u masi materijala unutar skupine bila je statistički značajna (p vrijednost < 0,001) s vrijednošću od 6,1 mg (± 2,7mg) za lijevane metalne nadogradnje i 6,4 mg (± 2,7mg) za kolčiće ojačane kompozitnim vlaknima. No srednja razlika nije bila statistički značajno različita kada su se uspoređivala oba materijala (p vrijednost > 0,05). **Zaključak:** I lijevana nadogradnja i vlaknima ojačani kompozitni intrakanalni kolčić slično su se prilagodili stijenkama korijenskog kanala.

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**Ključne riječi**
liječenje korijenskog kanala; rubno prijanjanje materijala za punjenje; tehnika kolčića i nadogradnje; vlaknima ojačani polimeri

## Uvod

Na endodontski liječenim zubima čest je znatan gubitak volumena tkiva zbog jakog oštećenja uzrokovanog karijesom, prekomjernim trošenjem ili ranijim restauracijama (1). Postendodontskom opskrbom želi se nadomjestiti izgubljeno zubno tkivo, ono koje je preostalo zaštititi od loma i spriječiti infekcije kanalnog sustava nakon liječenja (2). U slučaju nedovoljne količine preostaloga zubnog tkiva za adekvatnu opskrbu, upotrebljavaju se intrakanalno sidrene nadogradnje kojima se povećava retencijska površina (3).

Najčešći su razlozi za neuspjeh nadomjestaka retiniranih nadogradnjama karijes, endodontski neuspjesi, parodontne bolesti, lomovi korijena, odvajanje cementa od nadogradnje ili odvajanje zacementirane krunice od nadogradnje (4 – 7). Ti neuspjesi povezani su s nekoliko čimbenika u fazi izrade nadogradnje, a uključuju njezin oblik te način cementiranja, odnosno vrstu cementa (8).

Mnoštvo različitih materijala proizvedenih zahvaljujući napretku tehnologije nameću pitanje kvalitete prilagodbe intrakalanih kolčića korijenskom kanalu. Prilagodba se definira kao stupanj prianjanja između protetskog nadomjestka i potpornih struktura (9). Loše prilagođeni kolčići mogu stvoriti poluge

## Introduction

Endodontically treated teeth often have substantial loss of tooth tissue due to severe damage caused by decay, excessive wear or previous restorations (1). Restoration of endodontically treated teeth aims to replace the missing tooth structure, protect the remaining tooth structure from fracture and to avoid reinfection of the root canal after treatment (2). In a case of inadequate tooth tissue left, post constructions will help in retaining the core and final restoration *in situ* (3).

The most common types of post-retained restoration failures are caries, endodontic failures, periodontal disease, root fractures, post dislodgements, post-and-core separations and crown-core separations (4-7). These failures depend on a number of factors in the post preparation step that includes post design and cement or luting agent (8).

With a wide variety of materials being introduced with advanced technology, an adaptation of the post is one of the aspects to be taken into consideration. Adaptation is defined as the degree of fitting between the prosthesis and supporting structures (9). A poorly adapted posts might create levers

ra kao preciznost dosjeda između protetičkoga rada i potpornih struktura (9). Loše prilagođeni intrakanalni kolčići mogu stvoriti poluge unutar korijenskog kanala čime ga čine podložnijim lomovima (10, 11). To povećava naprezanje unutar kanala i mogućnost neuspjeha. Loše prilagođen intrakanalni kolčić stvara rubnu pukotinu koja, u slučaju nekvalitetnog cementiranja, može početi mikropropuštati (12). Takvo produljeno propuštanje uzrokovat će odcementiranje kolčića i na kraju će potaknuti uobičajene poteškoće koje se pojavljuju s nadogradnjama. Oralne tekućine, bakterijski toksini i sve vrste iona koji prodiru kroz sučelje restauracije i zuba mogu dovesti do rubne diskoloracije (13), sekundarnog karijesa i rubne pukotine (14 – 16).

Pasivna retencija kolčića povećava se kada je dobro prilagođen prostoru unutar prepariranog kanala i ako je cementni sloj tanak i ravnomjeran (17, 18). Tanak, ravnomjeran sloj cementa koji okružuje individualnu nadogradnju pomaže ograničiti koncentraciju naprezanja u korijenskom kanalu. Istraživanje koje su proveli Kremeier i suradnici (18) pokazalo je da deblji slojevi cementa povećavaju rizik od kontrakcijskog naprezanja, što rezultira smanjenom veznog čvrstoćom i većim naprezanjem tijekom polimerizacije. Deblji sloj cementa između nadogradnje i stijenke kanala mogao bi dislocirati kolčić (11, 19). Sučelje cementnog sloja i dentina mjesto je gdje se obično cement odvaja, što je posljedica zaostalih zračnih mjehurića i pora koje se stvaraju zbog polimerizacijskog naprezanja (20, 21). Zato dobro prilagođen intrakanalni kolčić koji odgovara obliku kanala može smanjiti rizik od odcementiranja koje poslije rezultira terapijskim neuspjehom (19).

Ako kolčić nije dobro prilagođen, u kanalu će se stvoriti praznina ili prostor koji je podložan bakterijskoj kontaminaciji. Unatoč dobrom apikalnom brtvljenju koje osigurava preostala gutaperka, bakterije iz koronarnoga dijela mogu se širiti u šuplje prostore, pa tako samo za nekoliko dana mogu proći apikalnih 3 do 5 milimetara punjenja (22). Malo se zna o intrakanalnoj adaptaciji kolčića ojačanih vlaknima (FRC). Zato je cilj ovog istraživanja analizirati prilagodbu lijevanih nadogradnji i FRC-a unutar korijenskog kanala. Dodatno će se usporediti kvaliteta prilagodbe lijevanih nadogradnji i intrakanalnih kolčića ojačanih vlaknima.

## Materijali i metode

Riječ je o eksperimentalnom istraživanju *in vitro*. Provedeno u je laboratoriju Stomatološkog fakulteta u Zdravstvenom kampusu Sveučilišta Sains u Maleziji.

PS softver (Dupont i Plummer, 1997.) korišten je kako bi se izračunala veličina uzorka sa standardnim devijacijama (σ). Uz vrijednost od 7,4 (23), ustanovljeno je da je za istraživanje potrebno 15 uzoraka. Pretpostavljajući da će se na njih 10 posto pojaviti problemi, pripremljeno je ukupno 17 uzoraka.

Nasumično je odabrano 17 izvađenih trajnih gornjih središnjih sjekutića dobivenih iz javnih i privatnih dentalnih klinika. Kriteriji za uključivanje bili su jednokorijenski zubi s ravnim kanalom i zrelim apeksom. Eventualne karijesne lezije morale su biti ograničene na područje do dva milimetra od caklinsko-cementnog spojišta. Zubi bez karijesa izvađeni iz

within the root canal, making the tooth more susceptible to fracture (10, 11). This increases the stress within the root and increases the chances of failure. A poorly adapted post will create a marginal gap in which the presence of insufficient cementation can lead to microleakage (12). The prolonged leakage will cause the separation of the post from the root canal and eventually lead to common failures of the post-core systems. Oral fluids, bacterial toxins and all kinds of ions that penetrate through the interfacial space between the restoration and the tooth may lead to marginal discoloration (13), secondary caries and marginal fracture (14-16).

A post's passive retention is improved when it adapts properly into the prepared post space and if the luting agent is thin and even (17, 18). A thin layer of cement instead of the different amount of luting agents surrounding the customized post helps to limit stress concentration in the root canal. A study by Kremeier et al. (18) demonstrated that thicker layers of luting agent increase the risk of shrinkage strain, resulting in reduced bond strength by creating more stress during polymerization. Thicker cement found between the post and the canal could lead to displacement of the post (11, 19). The cement-dentine interface is the site at which decementation generally occurs due to the bubbles and pores that form due to curing stress (20, 21). Therefore, a well-adapted post that fits the root canal shape can reduce the risk of debonding which is subsequently leading to failure of the post (19).

When a post does not adapt well, a gap or space will be created in the canal which will become a harboring place for bacterial infection. Despite having a good apical seal from the remaining gutta-percha, bacteria from the coronal portion can spread through it. It may take only a few days for bacteria to pass the apical 3-5mm of apical root canal filling (22). Little is known about the intra-canal adaptation of the fiber reinforced composite (FRC) post systems. Therefore, the aim of this study was to investigate the adaptation of cast post-and-core (CPC) and FRC post system inside the root canal. In addition, the CPC's adaptation quality will be compared with the FRC's adaptation quality.

## Materials and methods

This was an experimental study based on *in-vitro* procedures. It was performed in the Craniofacial Laboratory of School of Dental Sciences, Health Campus, Universiti Sains Malaysia.

PS software (Dupont and Plummer, 1997) was used to calculate the sample size with standard deviation (σ) which is assumed to be 7.4 (23) of the mean gamma count with 80% power and alpha 0.05. Fifteen samples were needed for this study. Having anticipated possible problems with 10% of samples during the procedure, total samples of 17 were prepared for this study.

Seventeen extracted human permanent maxillary central incisors were randomly selected and stored in normal saline solution until the beginning of the experiment. They were

parodontoloških razloga također su bili uključeni ako nisu bili napuknuti. Isključni kriteriji obuhvaćali su dodatni kanal, otvoreni apeks, kalcificirani kanal, resorpciju korijena, zavijeni kanal, nezreli apeks ili vidljive napukline na caklinsko-cementnom spojištu (CCS).

Svi su uzorci očišćeni, a vanjske naslage uklonjene su ultrazvučnim strugačem (EMS, Švicarska). Nakon toga je koronarni dio zuba odrezan horizontalno s uzdužnom osi od 2 mm incizalno od CCS-a na bukalnoj strani fisurnim dijamantnim svrdlom (Horico, Njemačka), a pritom je korišteno vodeno hlađenje u zračnoj turbini (Bien Air Dental, Švicarska).

U svim skupinama korijenski je kanal prepariran kemomehanički. Pravocrtni pristup koronarnoj i srednjoj trećini kanala osiguran je svrdlima Gates Glidden (MANI, Japan) veličine 2 i 3. Radna duljina za svaki zub određena je umetanjem ručnog instrumenta broj 10 u korijenski kanal do apeksa nakon čega je oduzeto 0,5 mm (24). Ručni instrumenti sve većih veličina i odgovarajuće radne duljine za svaki zub korišteni su za čišćenje kanala. Kao glavni radni instrument (Master Apical File = MAF) određen je onaj koji je prvi pružio otpor na apeksu. Tri sljedeće veličine instrumenata bile su po milimetar kraće od prijašnje radne duljine za instrumentaciju kanala. Radna duljina i MAF zabilježeni su za svaki zub. Između instrumentacija svaki je kanal ispiran 2,5-postotnim natrijevim hipokloritom i osušen papirnatim štapićima. Zatim je kanal napunjen gutaperkom primjenom tehnike lateralne kondenzacije i zabrtvljen cementom AH26 (Dentsply; Njemačka). Rendgenski je provjereno je li kanal potpuno napunjen, posebno u apikalnoj trećini. Dvadeset i četiri sata nakon inicijalne preparacije uzorci su preparirani za intrakanalni kolčić prema standardnom protokolu, ostavljajući 5 mm gutaperke radi apikalnog brtvljenja, a preostala je uklonjena svrdlima Gates Glidden.

Preparacija za kolčić provedena je posebnim svrdlom XP drill (Coltane Whaledent, SAD). Dužina individualne nadogradnje mjerena je od koronarne trećine apikalnog brtvila do koronarnog otvora s dodatna 2 mm (ukupno 4 mm od CCS-a). Kako bi se standardizirala, određeno je da će to biti tri četvrtine duljine korijena za svaki uzorak (25). Vrste intrakanalnih kolčića korištenih u ovom istraživanju vidi u tablici 1.

Za izradu FRC nadogradnji korišten je sustav *everStick* (Stick Tech Ltd, Finska) prema postupku koji su opisali Le Bell-Ronndolf i suradnici. (26). FRC kolčić veličine 1,5 mm umetnut je u kanal s dodatna 2 mm iznad koronarnog ruba, a zatim je 20 sekunda svjetlosno polimeriziran (Mini L.E.D OEM, Francuska, 420 – 480 nm). Nakon toga je izvađen iz kanala i dodatno osvijetljen 40 sekunda. Taj je snop dodan i svjetlosno polimeriziran kako bi, prema potrebi, ispunio preostali prostor unutar kanala sve dok kolčić ne sjedne pravilno u kanal. Dosjed nadogradnje unutar kanala potvrđen je rendgenski.

Otisak za lijevanu nadogradnju uzet je vinil-polisiloksanom – VPS-om (EXAMIX NDS, Japan) prema modificiranom protokolu koji su predložili Gavelis i Hope (27) te Trebilcock Jr. i Evans (28). Nisko viskozni otisni materijal ubrizgan je u kanal te je plastični kolčić umetnut kao dodatna potpora materijalu. Za uzimanje otiska korištena je žlica

obtained from both government dental clinics and private dental clinics. They met the inclusion criteria of this study: a single-rooted straight canal with mature apices, caries which was limited to 2mm from the incisal edge to cemento-enamel junction (CEJ) without involving the pulp and root. Non-carious teeth extracted due to periodontal problems and free from cracks and defects were also included. Exclusion criteria were: a tooth with extra roots and root canals, open apices, calcified canal, root resorption, curved roots, immature apices or any tooth with presence of other cracks or craze lines at the CEJ.

All specimens were cleaned and external debris was removed using an ultrasonic scaler (EMS, Switzerland). Thereafter, the coronal portion of the teeth was removed horizontally to the long axis, 2mm from incisal edge to the CEJ of the buccal surface with water cooled diamond fissure bur (Horico, Germany) in air turbine handpiece (Bien Air Dental, Switzerland).

Complete chemo-mechanical preparation was an essential step in root canal treatment of all groups. A straight line access to the coronal and middle third of the canal was obtained using a Gates Glidden drill (MANI, Japan) sized 2-3. The working length of each tooth was determined by inserting a no. 10 file into the canal until it appeared at the apex. After that, 0.5mm was subtracted from it (24). Files with increasing sizes and their corresponding working length for each tooth were inserted to clean the canal. The master apical file (MAF) was obtained when a degree of resistance or tug-back was felt upon removal of the file at the apical root. Once the MAF was obtained, three consecutive increasing sizes of files were inserted with reduction of 1mm from previous working length. The working length and the MAF were recorded for each tooth. Each canal was intermittently irrigated with 2.5% sodium hypochlorite and dried with paper points. Subsequently, the root was obturated with gutta percha with the lateral condensation technique and sealed with AH26 root canal sealer (Dentsply, Germany). An X-ray was taken for each tooth to confirm that each canal was fully obturated, especially at the apical third of the canal. Twenty four hours after initial preparation, the samples were prepared for post preparation following the standard technique, leaving 5mm of gutta-percha as apical seal while the remaining gutta-percha was removed using a Gates Glidden drills.

Post preparation was performed with a parapost XP drill (Coltane Whaledent, USA). The length of the CPC was measured from the coronal part of the apical seal up to the coronal opening with additional 2mm (overall 4mm from CEJ). In order to standardize the length of the post, the post length used was three-quarters of the root length of each specimen (25). The types of posts used in this study are shown in Table 1.

The FRC post was fabricated using everStick post (Stick Tech Ltd, Findland) and was based on a technique described by Le Bell-Ronndolf et al (26). An FRC post with 1.5mm size, was placed inside the canal, with extra 2mm above the coronal margin, and was subsequently light cured with a light-curing device (Mini L.E.D OEM, France, 420-480 nm), for 20 seconds. After that, the FRC post was removed

**Tablica 1.** Vrste intrakanalnih kolčića korištenih u ovom istraživanju
**Table 1** The types of posts used in this study

| Naziv • Brand | Sastav • Composition | Proizvođač • Manufacturer |
|---|---|---|
| Indirektna lijevana nadogradnja METAPLUS® VK • Indirect post cast from METAPLUS® VK | nikal 6,2 %, krom 25,8 %, molibden 11,0 %, silicij 1,5 %, aluminij < 0,4%, mangan 0,1% • nickel 62.2 %, chromium 25.8 %, molybdenum 11.0%, silicon 1.5 %, aluminum <0.4%, manganese 0.1% | Proizvedeno u Njemačkoj • Hergestellt in Deutschland |
| everStick | Silanizirana E-staklena vlakna impregnirana polimetilmetakrilatom (PMMA) i bis-GMA-om • silanated E glass fiber impregnated with polymethylmethacrylate (PMMA) and bis-GMA | Stick Tech Ltd, Turku, Finska • Stick Tech Ltd, Turku, Finland |

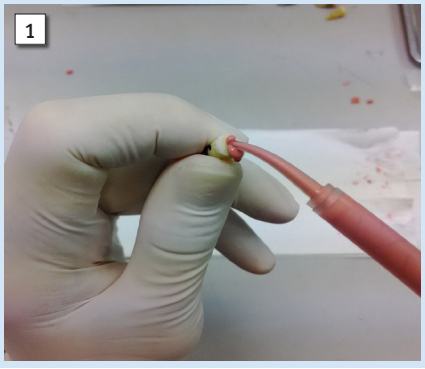
napunjena gustim VPS-om (EXAMIX NDS, Japan). Nakon stvrdnjavanja otisci su poslani u laboratorij kako bi se izradile lijevane nadogradnje. Svaki je kanal evaluiran s oba sustava nadogradnje. Svaki zub s nadogradnjom umetnutom u kanal izvagan je dva puta digitalnom vagom (I GR200, A & D Company Limited, Japan) s točnošću od 0,0001 te su izračunate prosječne vrijednosti. Nisko viskozni VPS otisni materijal (EXAMIX NDS, Japan) unesen je u kanal nakon čega je umetnuta nadogradnja prije stvrdnjavanja materijala, kao što se vidi na slici 1. Nakon stvrdnjavanja silikona višak materijala koji je iscurio koronarno izrezan je skalpelom br. 15, kao na slici 2. VPS, zajedno s nadogradnjom u svakom zubu, izvagan je dva puta digitalnom vagom (I GR200, A & D Company Limited, Japan) te su izračunate prosječne vrijednosti. Svi su podatci uneseni u tablice. Razlike u masi prije unošenja VPS-a i nakon toga postupka čine prostor u kanalu koji nije bio ispunjen intrakanalnim kolčićem.

Podatci su analizirani statističkim paketom za IBM društvene znanosti (SPSS), verzija 22.0. Nezavisni t-test korišten je za usporedbu podataka iz obje skupine. P-vrijednost smatrana je značajnom ako je bila < 0,05.

from the canal and further light-cured for 40 seconds outside the canal. Additional bundle was added and light cured to fit the remaining space left inside the canal if necessary until the post fitted the canal properly. An x-ray was taken to confirm the fitting of the posts inside the canal.

Impression for CPC was recorded following a protocol modified by Gavelis and Hope (27) and Trebilcock Jr and Evans (28) using polyvinyl siloxane (PVS) impression material (EXAMIX NDS, Japan). Light body impression material was injected into the canal and plastic sprue was inserted into the canal to add support to the impression material. A tray loaded with a heavy body PVS (EXAMIX NDS, Japan) was then seated. The impression was allowed to set and sent to the laboratory for die fabrication and cast fabrication. Each canal was assessed for both post systems. Each tooth with the post inserted into the canal was weighed twice using a digital scale (AND GR200, A&D Company Limited, Japan) with the accuracy of 0.0001 and the average value was calculated. A light body PVS impression material (EXAMIX NDS, Japan) was loaded into the canal followed by the post before the PVS hardened as shown in Figure 1. After the PVS set, the excess of impression material on the coronal tooth tissue was cut with scalpel blade no. 15, which is shown in Figure 2. The PVS together with the post still intact in each tooth was weighed twice using a digital scale (AND GR200, A&D Company Limited, Japan) to determine an average value. Data were summarized in tabular form. The differences in weights before and after PVS placement represent the space of the canal which was not covered by the post.

Data were collected using Statistical Package for the IBM Social Sciences (SPSS) version 22.0. An independent T-test was used to determine and compare the data collected from both groups. The p-value was set as significant at $p<0.05$.





**Slika 1.** Otisni materijal uštrcan je u kanal prije umetanja kolčića
**Figure 1** Impression material is injected into the canal before insertion of the post
**Slika 2.** Višak otisnog materijala uklonjen je skalpelom
**Figure 2** Excessed impression material is removed using a scalpel blade

## Rezultati

Procjenom mase otisnoga materijala između stijenke kanala i intrakanalnog kolčića utvrđena je njegova prilagodba. Za sve uzorke zabilježeno je povećanje mase nakon unošenja otisnog materijala. Srednje razlike u masi prije i poslije unošenja otisnog materijala za lijevanu nadogradnju i za FRC sustav nalaze se u tablicama 2. i 3. Srednja razlika u masi za oba materijala bila je statistički značajna (p vrijednost < 0,001). Srednja razlika u masi materijala za otiske bila je 6,1 mg (2,7 mg) za lijevanu nadogradnju i 6,4 mg (2,7 mg) za FRC. Najveća razlika u masi od 12,2 mg zabilježena je za zub broj 10 s intrakanalnim kolčićem ojačanim vlaknima.

Testirana je normalnost distribucije te je utvrđeno da su podatci bili normalno distribuirani. Stoga je za statističku analizu korišten nezavisni t-test s intervalom pouzdanosti od 95 posto. Iz tablice 4. vidi se da je srednja razlika u masi između lijevane nadogradnje i nadogradnje FRC-om iznosila 0,2 mg. No razlika nije bila statistički značajna (p-vrijednost < 0,05).

## Results

When we evaluated the weight of the remaining impression material between the canal wall and the post, we could see that the intimacy of fit of the post was obtained. All specimens showed an increase in weight after the impression material was inserted. The mean difference in weight before and after insertion of the impression material in both CPC and the FRC post systems is shown in Table 2 and Table 3. The mean difference in weight for both materials is statistically significant (P-value <0.001). The mean difference of weight of the impression material is 6.1mg (2.7mg) for CPC and 6.4mg (2.7mg) for the FRC post system. The largest difference in weight is observed in tooth number 10 which adapted to the FRC post system with the value of 12.2mg.

A normality test was performed and the data were found to be normally distributed. Thus, an independent T-test was used for statistical evaluation at a 95% confidence interval. It can be observed (Table 4) that the mean difference in weight between the CPC and the FRC post system is 0.2mg. However, the difference is not statistically significant (P-value >0.05).

**Tablica 2.** Masa za lijevane nadogradnje prije unošenja otisnog materijala i nakon toga postupka
**Table 2** Weights before and after impression material insertion for CMP posts

| Varijable • Variables | Prije unošenja srednja vrijednost (SD) • Before insertion mean (SD) | Nakon unošenja srednja vrijednost (SD) • After insertion mean (SD) | Srednja razlika (95 % IP) • Mean diff. (95% CI) | t-statistika (df) • t-statistic (df) | *p*-vrijednost • *P*-value |
|---|---|---|---|---|---|
| Prilagodba (g) • Adaptation (g) | 1.1247 (0.1640) | 1.1308 (0.1639) | 0.0061 (0.0048, 0.0075) | 9.546 (16) | <0.001 |

**Tablica 3.** Masa za lijevane nadogradnje za *everStick* kolčiće prije unošenja otisnog materijala i nakon toga postupka
**Table 3** Weights before and after impression material insertion for everStick posts

| Varijable • Variables | Prije unošenja srednja vrijednost (SD) • Before insertion mean (SD) | Nakon unošenja srednja vrijednost (SD) • After insertion mean (SD) | Srednja razlika (95 % IP) • Mean diff. (95% CI) | t-statistika (df) • t-statistic (df) | *p*-vrijednost • *P*-value |
|---|---|---|---|---|---|
| Prilagodba (g) • Adaptation (g) | 0.7020 (0.1570) | 0.7084 (0.1568) | 0.0064 (0.0050, 0.0078) | 9.823 (16) | <0.001 |

**Tablica 4.** Srednja razlika u masi između lijevanih i *everStick* nadogradnji
**Table 4** Mean weight difference between the CMP and everStick post system

| Varijable • Variables | LN (n=17) srednja vrijednost (SD) • CMP (n=17) mean (SD) | FRC (n=17) srednja vrijednost (SD) • Post (n=17) mean (SD) | Srednja razlika (95 % IP) • Mean diff. (95% CI) | t-statistika (df) • t-statistic (df) | *p*-vrijednost • *P*-value |
|---|---|---|---|---|---|
| Prilagodba (g) • Adaptation (g) | 0.0061 (0.0027) | 0.0064 (0.0027) | -0.0002 (-0.0021, 0.0016) | -0.264 (32) | 0.794 |

## Rasprava

U ovom su istraživanju korišteni središnji sjekutići jer imaju jedan ravan kanal koji je jednostavniji za obradu i rukovanje, što ih u ovom slučaju čini najprikladnijim uzorcima.

## Discussion

Central incisor teeth were used for this study. The majority of them had a single straight canal, which is easier to handle. In this way, they were the most suitable samples for this study.

Dobiveni rezultati pokazali su da nema razlike u prilagodbi lijevanih i FRC nadogradnji. Razlog može biti činjenica da su oba sustava zbog načina izrade slijedila oblik kanala. Uz pravilan oblik, individualna ili laboratorijski izrađena nadogradnja koja prati oblik kanala, kako bi osigurala maksimalnu retenciju, omogućuje ravnomjerniju raspodjelu naprezanja kroz cijelu strukturu zuba (29, 30). Još jedan čimbenik koji bi mogao utjecati na rezultate jest preparacija kanala. U ovom istraživanju oblikovani su svrdlom paralelnih stijenki kako bi se osiguralo da svi imaju sličan oblik, bez obzira na razlike u indikaciji u kliničkoj praksi. Prijašnje istraživanje sugerira da se lijevane nadogradnje koriste kad nema potrebe za dodatnim uklanjanjem dentina kako bi se spriječila perforacija (2). Kliničke smjernice (31) proizvođača preporučuju *everStick* kao nadogradnju koja se prilagođava morfologiji kanala, uključujući i zakrivljene, ovalne ili velike kanale uz minimalnu potrebu za preparacijom. No u ovom istraživanju svi su kanali preparirani svrdlom XP (Coltane Whaledent, SAD) kako bi se standardizirao oblik kanala za oba materijala.

Za mjerenje prilagodbe nadogradnji u kanalu u ovom je istraživanju preinačena tehnika kojom su se koristili Pitigoi-Aron G i suradnici. (23). Umjesto uklanjanja kolčića iz korijenskog kanala i vaganja otisnog materijala koji je ispunio prazninu između kolčića i stijenke korijenskog kanala, masa otisnog materijala izmjerena je digitalnom vagom (AND GR200, A&D Company Limited, Japan) dok je bio intaktan u prostoru kanala zajedno s kolčićem. Ta modifikacija trebala je pridonijeti smanjenju moguće pogreške jer dio otisnog materijala može ostati unutar kanalnog prostora, iako je kolčić u cijelosti uklonjen iz korijenskog kanala. Razlika u masi prije unošenja otisnog materijala i poslije toga postupka pokazuje koliko je raspoloživog prostora za cement između kolčića i stijenki kanala. Prostor između stijenke korijenskog kanala i kolčića ispunjava cement. No debljina cementnog sloja može utjecati na dugovječnost nadogradnje. Pretjerano debeo sloj cementa upućuje na lošu prilagodbu nadogradnje, što može pogodovati odvajanju cementa (11, 32) i povećava kontrakciju polimera (33).

Mnogobrojna su istraživanja provedena i objavljena o intrakanalnim kolčićima ojačanima vlaknima i njihovim svojstvima, a posebno se ističu usporedbe s konvencionalnim metalnim nadogradnjama, te usporedbe različitih komercijalno dostupnih sustava kolčića ojačanih vlaknima (34 – 37). Ukratko, većina daje prednost kolčićima ojačanima vlaknima u odnosu na druge sustave (36 – 39). FRC kolčići se, zbog fleksibilnosti, prilagođavaju korijenskom kanalu pa nema nikakve potrebe za pripremom. Stoga se mogu konstruirati unaprijed i jednostavno prilagoditi obliku kanala direktno na pacijentu. Staklena vlakna mogu se prilagoditi dodavanjem ili rezanjem materijala prema veličini i obliku korijenskog kanala da bi se postigla bolja prilagodba stijenkama unutar kanala. Većina kanala u zubima koji su korišteni u ovom istraživanju imala je veći promjer od FRC vlakana. Zato su dodani dodatni snopovi kako bi se prilagodili kanalu. No zbog dodavanja drugoga snopa materijal ne bi mogao dosegnuti apikalni dio kanala. Zato je mali dio odrezan i preoblikovan tako da se sužava na kraju, čime se omogućuje ulazak u apikalni dio.

In this study, the results showed that there was no difference in the adaptation of both, the CPC and the FRC post. This may be due to the fact that both materials are custom-made to follow the shape of the canal. With proper design, a custom-made or laboratory-fabricated post can conform to a canal of any shape to provide maximum retention, thus allowing a more even distribution of stress throughout the tooth structure (29, 30). Another factor that might influence the results is the preparation of the canal itself. In this study, the canals were shaped using a parallel drill to ensure that all canals have a similar shape, which is in contrast to the indication for the CPC and FRC post itself. A previous study suggested that the CPC is to be used when no additional dentine removals are indicated to prevent perforation (2). The manufacturer's clinical guide (31) recommends everStick as the posts to adapt to the morphology of the canals including curved, oval or large rooted canals with minimal canal preparation needed. However, in this study, all the canals were drilled with parapost XP drills (Coltane Whaledent, US) for standardization of shape of the canals for both materials.

The adaptation of posts measured in this study was modified according to the method used by Pitigoi-Aron G et al (23). Instead of removing the post from the root canal and weighing the remaining impression material that filled the gap between the post and root canal wall, the remaining impression material was measured with a digital scale (AND GR200, A&D Company Limited, Japan) while it was still intact inside the post space together with the post. This modification was done to reduce errors since residual impression materials may remain inside the post space even though the post has been completely removed from the root canal. The difference in weight before and after the impression material insertion indicated the amount of space available between the posts and the canal walls. The space between the root canal wall and the post allows for the cement to sit in. However, the thickness of cement filling in the spaces can affect the longevity of the post system. Excessively thick cement represents a poor adaptation of the post, which may cause debonding (11, 32) and increases shrinkage of the polymer that is related to the volume of restoration (33).

Numerous studies have been carried out and scientific papers were published on fiber posts and their properties, particularly those on comparison between fiber posts and conventional metallic posts as well as the comparison of different commercially available fiber post systems (34-37). In summary, their results showed that fiber reinforced posts had a higher survival rate compared to other post systems (36-39). An FRC post has the ability to adapt to the root canal without any preparation needed due to its soft and flexible characteristics. For this reason, the FRC posts can be constructed beforehand and easily adapted to the shape of the canal at the chair side. The glass fibers can be customized by adding or cutting the material according to the size and shape of the root canals to produce a better adaptation within the root canal. Most of the canals in the teeth used in this study had larger diameters than the FRC bundle. Therefore, another bundle was added in order to fit it into the canal. However, by adding the second bundle to the loose bundle of fibers, the

Budući da sustav *everStick* omogućuje modeliranje staklenih vlakana, može se jednostavno odrezati škarama.

Ranija istraživanja pokazala su koliko je važna prilagodba intrakanalnih kolčića u odnosu na okluzijsku silu, čvrstoću, otpornost na lom itd. (7, 40, 41). Zato je intrakanalna prilagodba ključna u osiguravanju dugovječnosti restauracije.

Na kraju - iz ovog istraživanja proizlazi da se prilagodba za konvencionalne lijevane nadogradnje i FRC sustav ne razlikuje značajno. To pokazuje da se FRC može smatrati izvrsnom alternativom za konvencionalne lijevane nadogradnje. No ovo istraživanje bilo je usmjereno samo na prilagodbu kolčića prije cementiranja. Potrebna su dodatna istraživanja koja bi se bavila drugim svojstvima i trajnošću restauracija koje uključuju FRC sustav nadogradnji, kao što je učinak termocikliranja i cikličkog opterećenja kako bi se mogao općenito preporučiti.

## Zaključci

Uzimajući u obzir ograničenja ovog istraživanja, nije ustanovljena statistički značajna razlika u prilagodbi između konvencionalnih lijevanih nadogradnji i kompozitnih intrakanalnih kolčića ojačanih vlaknima (*everStick*). Stoga se može zaključiti da su konvencionalne nadogradnje i kompozitni kolčići ojačani vlaknima (*everStick*) imali sličnu prilagodbu u endodontski liječenim gornjim središnjim sjekutićima.

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Autor nije u sukobu interesa.

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material would not be able to reach the apical part of the canal. Therefore, a small portion of the bundle was cut and remolded back to make a tapered end allowing it to fit into the apical part of the canal. Since everStick is a moldable glass fiber, it can be easily cut using a pair of scissors.

Several previous research studies have pointed to the importance of adaptation of post systems in relation to occlusal loading, bond strength, fracture resistance etc. (7, 40, 41).

The authors also concluded that adaptation plays an essential role in survival probability of endodontically treated teeth restored with fiber posts.

The results of this study revealed that adaptation of both the CPC and the FRC post systems did not differ significantly. They showed that the FRC can be an excellent alternative to the conventional CPC systems. However, this study focused only on the adaptation aspect of the post before cementation. More research is needed to explore mechanical properties, or other performance properties and longevity of restoration by the FRC post system such as effects after thermal cycling and cyclic loading process, which will be widely accepted by dentists and patients.

## Conclusions

Within the limits of the present study, there was no significant difference in adaptation between the conventional cast post-and-core and fiber reinforced composite post (everStick). Therefore, it can be concluded that conventional cast post- and - core and fiber reinforced composite posts (everStick) showed similar adaptation in endodontically treated maxillary central incisors.

## Conflicts of interest

No potential conflicts of interest were disclosed

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**Abstract**

**Background:** The purpose of this study was to compare the adaptation of fiber reinforced composite post system and cast post-and-core. **Methods:** 17 extracted human permanent maxillary central incisors were endodontically treated following the standard protocol. 17 fiber reinforced composite post had been fabricated and adapted to the prepared parallel root canals. A light body poly vinyl siloxane (EXAMIX NDS, Japan) impression material was inserted into the root canals followed by the post. A digital scale was used to measure the weight of the remaining material that filled the gap between the post and the canal wall. The adaptation was indicated by the weight difference before and after impression material insertion. The same procedures were repeated with 17 cast post-and-core in the same teeth specimens. **Result:** The mean difference for the weight of the material within the group was statistically significant (P-value <0.001) with the value of 6.1mg(± 2.7mg) for cast metal post and 6.4mg(± 2.7mg) for fiber reinforced composite post. However, the mean difference was not statistically significant when compared with both materials (P-value>0.05). **Conclusions:** Both cast post-and-core and fiber reinforced composite post systems showed similar adaptation to the canal.

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Root Canal Therapy; Dental Marginal Adaptation; Post and Core Technique; fiberglass reinforced polymers

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