ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta stomatol Croat. 2014;48(1):16-24.
IZVORNI ZNANSTVENI RAD
ORIGINAL SCIENTIFIC PAPER

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Učinak otopina za ispiranje korijenskih kanala na mikrozateznu snagu vezivanja fiberglasnih kolčića

Effect of Endodontic Irrigating Solutions on the Micro Push-out Bond Strength of a Fibre Glass Dowel

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Sažetak
Svrha: Željelo se procijeniti učinak različitih otopina za endodontsku irigaciju na mikrozateznu snagu istiskivanja adhezivno cementiranih fiberglasnih kolčića. **Materijali i metode:** Pripremljeno je 70 komadića kravljih zuba od 16 milimetara i nasumce podijeljeno u sedam grupa (n=10), ovisno o vrsti upotrijebljene otopine za irigaciju prije cementiranja intrakanalnih fiberglasnih kolčića: **G 1**: 5,25-postotni NaOCl + 17-postotna EDTA; **G 2**: 5,25-postotni NaOCl; **G 3**: 17-postotna EDTA; **G 4**: 2-postotni klorheksidinski gel; **G 5**: 70-postotni alkohol; **G 6**: 11,5-postotna poliakrilna kiselina; **G 7**: fiziološka otopina (kontrola). Nakon tretiranja intrakanalnog dentina, fiberglasni kolčići učvršćeni su samojetkajućim adhezivnim cementom (RelyX Unicem). Od svakog je zuba niskoturažnom pilom odrezano šest komadića debljine 1,00 ± 0,05 milimetara iz koronarne, središnje i apikalne trećine (dva komadića po trećini). Obavljeni su i testovi mikroizbijanja s pomoću poprečne glave brzine 0,5mm/min., a podatci (MP-a) su statistički analizirani ANOVA-om te Tukeyevim i Dunnettovim testom. **Rezultati:** Među tekućinama za irigaciju pronađena je statistički značajna razlika (p<0,0001), no među trećinama korijena razlika nije bila značajna (p=0,0591). Od svih skupina ona G 5 pokazala je najveću snagu vezivanja (p<0,0001). Korištenje 70-postotnog alkohola povećalo je vrijednosti vezivanja za 53 posto u usporedbi s kontrolnom skupinom. **Zaključak:** Korištenje 70-postotnog alkohola povećalo je snagu vezivanja fiberglasnih kolčića za dentinske zidove. Trećine korijena nisu utjecale na potrebnu snagu istiskivanja kolčića iz korijenskog dentina (koronarna, srednja i apikalna).

Zaprimljen: 16. lipnja 2013.
Prihvaćen: 30. siječnja 2014.

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Ključne riječi
zatezna čvrstoća; nadogradnja, tehnika; korijenski kanal, sredstva za ispiranje

Uvod

Korištenje otopina za dezinfekciju prije nego što se počne s postupkom vezivanjem može utjecati na postupak adhezije jer mijenja svojstva nekih hidrofilnih smola (1, 2). Ostatci tih tvari mogu također spriječiti duboko prodiranje adhezivnog sredstva i njegov neposredni kontakt s dentinom, a utječu i na postupak adhezije (1). Procjenjivale su se kemijske tvari za čišćenje korijenskih kanala nakon terapije i prije postavljanja adhezivnih sustava jer se smatra da smanjuju intrakanalnu adheziju (3 – 5). Zna se da se, nakon endodontske terapije stvorena naslaga nečistoće i strugotine, mora ukloniti kako bi se povećala retencija intrakanalnih kolčića (6). Korišteno je nekoliko otopina i njihovih kombinacija predloženih kao pomoć kod čišćenja i dezinfekcije korijenskih kanala te uklanjanje naslaga nečistoće, među kojima su etilendiamintetra octena kiselina (EDTA) i natrijev hipoklorit (NaOCl) uz EDTA-u (7, 8).

Introduction

The use of disinfecting solutions prior to bonding procedures can interfere with the adhesion process, altering the properties of some hydrophilic resins (1, 2). Residues of these substances may also impede the deep penetration of the bonding agent and its intimate contact with dentin, also affecting the adhesion process (1).

The use of chemical agents for cleaning of root canals after retreatment and prior to the application of adhesive systems has been evaluated because these substances have been pointed as the responsible for the decrease of intra-radicular adhesion (3-5).

It is known that the smear layer and debris formed by the action of endodontic irrigants should be removed to increase the retention of intra-radicular dowels (6). Therefore, several chemical solutions and combinations of solutions have been proposed to promote cleaning and disinfection of root

Sastav adhezivnih sustava može utjecati i na snagu vezivanja ako se NaOCl nanosi na jetkani dentin (9 – 11). Dokazano je da 5-postotni NaOCl ili 3-postotni hidrogenov peroksid mogu smanjiti kvalitetu adhezije zbog rezidualnog kisika koji se stvara od tih tvari i inhibira polimerizaciju smole za vezivanje. Taj učinak varira ovisno o sastavu primijenjenih adhezivnih sustava (3, 12). NaOCL također oštećuje organske komponente dentina, uglavnom kolagena, što može utjecati na difuziju smolastih monomera kroz demineralizirane strukture (13). Korištenje kemijskih tvari tijekom terapije korijenskih kanala može inhibirati vezivanje adhezivnih sustava i smolastih cemenata za dentin jer njihove zaostale komponente i nusprodukti mogu difundirati kroz dentinske tubule i utjecati na polimerizaciju monomera u demineraliziranom dentinskom matriksu i na prodiranje smole u tubularnu strukturu dentina (3, 12). Premda se zna da kemijske tvari koje se primjenjuju u terapiji intraradikularnog dentina mogu utjecati na adheziju, malo je istraživanja o njihovu djelovanju na endodontski liječeni zub koji dobiva fiberglasni intrakanalni kolčić (3, 12). U ovom istraživanju procijenjen je učinak različitih otopina za endodontsku irigaciju na vezivnu snagu fiberglasnih kolčića za dentin s pomoću tehnike mikroistiskivanja.

Materijali i metode

Odabrano je sedamdeset tek ekstrahiranih kravljih inciziva s ravnim kanalima, sličnih oblika i dimenzija te sa zatvorenim apeksima. Nasumce su izabrani i provjereni imaju li korijenski karijes, pukotine ili strukturne defekte. Zubi su zatim prerezani poprečno ispod cementno-caklinske granice vodom hlađenim dvostranim dijamantnim diskom (KG Sorensen, Barueri, SP, Brazil). Dobiveni komadići od 16 milimetara izmjereni su digitalnom pomičnom mjerkom (Isomet 1000; Buehler Inc., Lake Buffer, IL, SAD). Kako bi se uzorci standardizirali, korišteni su samo oni kojima svrdlo #5 Larko (Ângelus Ind. Prod. Odontol., Londrina, PR, Brazil) nije moglo pasivno prodrijeti u kanal, što znači da je promjer korijenskih kanala odgovarao promjeru svrdla.

Korijenski kanali instrumentirani su i prošireni svrdlima #3 i #4 Gates Glidden (Dentsply Ind. Com. Ltda., Petrópolis, RJ, Brazil) te je silikonskim stoperima ograničeno prodiranje do 15 milimetara.

Instrumentirani kanali irigirani su 2,5-postotnim NaOCl-om, posušeni apsorbirajućim papirnatim šiljcima i napunjeni gutaperkinim štapićima uz endodontski cement na bazi epoksismole (Sealer 26; Dentsply, Petrópolis, RJ, Brazil). Kako bi se punjenja potvrdila, snimljeni su periapikalni radiogrami. Segmenti korijena očišćeni su gazom natopljenom u alkohol i pohranjeni 24 sata u destiliranu vodu zagrijanu na 37°C. Nakon toga korijenska su punjenja skraćena za četiri milimetra u apikalnoj trećini i to svrdlom #4 Gates Glidden (Dentsply Ind. Com. Ltda., Petrópolis, RJ, Brazil). U kanal je jednim pokretom uvedeno svrdlo #5 Largo

canals as well as removal of smear layer, among which ethylenediaminetetraacetic acid (EDTA), and sodium hypochlorite (NaOCl) associate with EDTA (7,8).

The composition of adhesive systems may also affect the bond strength when NaOCl is applied to the etched dentin (9-11). It has been shown that 5% NaOCl or 3% hydrogen peroxide may decrease the adhesion quality due to the presence of residual oxygen produced by these substances, thus inhibiting the polymerization of the bonding agent. However, this effect seems to vary according to the composition of the adhesive system employed (3,12). NaOCl also causes damage to the organic components of dentin, mainly collagen, which may affect the diffusion of resin monomers through the demineralized structure (13).

The use of chemical irrigants during root canal treatment may have a deleterious effect on binding of adhesive systems and resin cements to dentin since their residues and by-products can diffuse through the dentin tubules, affecting the polymerization of monomer in the demineralized dentin matrix and resin penetration into the tubular dentin structure (3,12). Although it is known that the chemical substances used in the treatment of intra-radicular dentin may affect adhesion, but there is little research on their behaviour with respect to endodontically treated teeth that will receive fibre glass dowels (3,12). Therefore, this study evaluated the effect of different endodontic irrigating solutions on the micro push-out bond strength of a fibre glass dowel to dentin.

Material and Methods

Seventy freshly extracted mandibular bovine incisors with straight roots and of similar shape and dimensions and closed apices were selected from a random collection and checked for absence of root caries, cracks and structural defects. The teeth were sectioned transversally below the cementoenamel junction with a water-cooled double-faced diamond disc (KG Sorensen, Barueri, SP, Brazil) to obtain 16-mm-long apical root segments, as measured with a digital caliper (Isomet 1000; Buehler Inc., Lake Buffer, IL, USA).

In order to have a standardized sample, only root segments in which #5 Largo drill (Ângelus Ind. Prod. Odontol., Londrina, PR, Brazil) did not penetrate into the canal were used in the study. This way, the diameter of all root canals would correspond to the diameter of this drill.

The root canals were instrumented and widened with #3 and #4 Gates Glidden drills (Dentsply Ind. Com. Ltda., Petrópolis, RJ, Brazil) with a silicone stopper to limit penetration to 15 mm. The instrumented canals were irrigated with 2.5% NaOCl, dried with absorbent paper points and filled by gutta-percha cones and an epoxy resin-based endodontic sealer (Sealer 26; Dentsply, Petrópolis, RJ, Brazil). In order to verify the obturation quality, periapical radiographs were taken. The root segments were cleaned with gauze soaked in alcohol and stored in distilled water at 37°C during 24 hours.

After this period, the root fillings were reduced to a length of 4 mm in the apical third using a #4 Gates Glidden drill (Dentsply Ind. Com. Ltda., Petrópolis, RJ, Brazil).

(Ângelus Ind. Prod. Odontol., Londrina, PR, Brazil) kako bi se preparirao prostor za kolčić. Nakon pripreme prostora za kolčić, kanali su irigirani destiliranom vodom i posušeni papirnatim šiljcima. Ima li ostataka gutaperke na zidovima, provjereno je radiološki. Korišteni su prefabricirani fiberglasni kolčići (Reforpost; Ângelus Ind. Prod. Odontol., Londrina, PR, Brazil) i isprobani dosežu li do dna prepariranog prostora. Uzorci su nakon toga nasumce podijeljeni u sedam skupina (n=10), ovisno o korištenoj otopini za irigaciju prije cementiranja intrakanalnih fiberglasnih kolčića (tablica 1.).

A #5 Largo drill (Ângelus Ind. Prod. Odontol., Londrina, PR, Brazil) was introduced into the canal in a single movement to complete dowel space preparation. Following the dowel space preparations, the canals were irrigated with distilled water and dried with absorbent paper points. Presence of any residual gutta-percha in the walls of dowel space was checked by radiographic evaluation. The prefabricated fibre glass dowels (Reforpost; Ângelus Ind. Prod. Odontol., Londrina, PR, Brazil) were tried to ensure that the they would reach the bottom of the dowel space. The specimens were then randomly assigned to 7 groups (n=10) according to the type of irrigating solution used prior to the cementation of intra-radicular fibre glass dowels: (Table 1).

Tablica 1. Raspodjela prema skupinama, ovisno o korištenoj otopini za irigaciju i tretman intrakanalnog dentina
Table 1 Distribution of groups according to the irrigating solution used for treatment of intracanal dentin.

Grupe • Groups	N	Otopine za irigaciju • Irrigating solution	Tretman intrakanalnog dentina • Treatment of intracanal dentin
G1	10	5.25% NaOCl + 17% EDTA	Irigacija 1 min –NaOCl i 3 min. EDTA • Irrigation for 1 min with NaOCl and 3 min with EDTA
G2	10	5.25% NaOCl	Irigacija – 1 min. • Irrigation for 1 min
G3	10	17% EDTA	Irigacija – 3 min. • Irrigation for 3 min
G4	10	2-% klorheksidinski gel • 2% chlorhexidine gel	Irigacija – 1 min. • Irrigation for 1 min
G5	10	70-% alkohol • 70% alcohol	Irigacija – 1 min. • Irrigation for 1 min
G6	10	Poliakrilna kiselina • Polyacrylic acid	Primijenjeno – 30 s • Application for 30 s
G7 (kontrola • control)	10	Fiziološka otopina • Saline	Irigacija – 1 min. • Irrigation for 1 min

Prije cementiranja svi su se kolčići čistili u alkoholu jednu minutu i mikročetkicom (KG Sorensen Ind. Com. Ltda., Barueri, SP, Brazil) je, prema uputama proizvođača, tijekom jedne minute postavljen sloj silana (Silano prosil; FGM Prod. Odontológicos Ltda., Joinville, SC, Brazil).

Kolčići su učvršćeni samojetkajućim kompozitnim cementom (Rely-X U100; 3M/ ESPE, St. Paul, MN, SAD) prema uputama proizvođača. Cement je postavljen na njihovu površinu i na ulaz u korijenski kanal. Pritišćući prstima kolčići su uvedeni do pune dužine, a višak je odmah uklonjen dentinskim ekskavatorima. Zubi su stavljeni u posebno napravljenu posudu za svjetlosnu polimerizaciju koja omogućuje fotoaktivaciju dvostruko polimerizirajućeg cementa bez interferencije običnog svjetla. Fotoaktivacija halogenim svjetlom seta intrakanalnih kolčića trajala je 40 sekundi direktno na njihov koronarni kraj. Svi zubi s cementiranim kolčićima držani su u vlažnoj gazi deset minuta i zatim pojedinačno pohranjeni 24 sata u označene svjetlonepropusne plastične posude napunjene s 10 mL deionizirane vode zagrijane na 37^0 C.

Zubi s cementiranim kolčićima fiksirani su autopolimerizirajućom akrilatnom smolom (Duralay; Reliance Dental Mfg. Co., Place Worth, IL, SAD) u samoregulirajući metalni stezač za osiguranje okomitih rezova u odnosu na uzdužnu osovinu korijena. Korijeni s cementiranim kolčićima rezani su dijamantnom oštricom Wafering 3" (76 mm; Buehler Ltd., Lake Bluff, IL, SAD) na uređaju s malim brojem okretaja (ELQUIP, São Carlos, SP, Brazil) i hlađeni destiliranom vodom. Kod svakog korijena prvi je rez učinjen jedan mili-

Prior to cementation, all dowels were cleaned with alcohol for 1 min and a layer of a silane solution (Silano prosil; FGM Prod. Odontológicos Ltda., Joinville, SC, Brazil) was applied with a microbrush tip (KG Sorensen Ind. Com. Ltda., Barueri, SP, Brazil) for 1 min, according to the manufacturer's instructions. The dowels were cemented with self-adhesive resin cement (Rely-X U100; 3M/ ESPE, St. Paul, MN, USA) according to the manufacturer's instructions. The cement was applied onto the surface of the dowels and into the orifice of the root canals. The dowels were inserted into the dowel space to full depth by using finger as pressure, and excess was immediately removed with dentin excavators. The teeth were placed in custom-made light-proof polymerization box that permitted photoactivation of the dual resin cement without interference of light. Photoactivation of the tooth-dowel set was performed for 40 seconds through the dowels, with the tip of a halogen light unit directly in contact with the coronal end of the dowels. All dowel-cemented roots were maintained by a moist gauze for 10 minutes and were then stored in individual, labelled light-proof plastic receptacles containing 10 mL of water deionized at 37^{0}C for 24 hours.

After that, the dowel-cemented roots were fixed with autopolymerizing acrylic resin (Duralay; Reliance Dental Mfg. Co., Place Worth, IL, USA) to the self-adjustable vertical metallic shaft of a delineator to ensure that the sectioning procedures would be done perpendicularly to the long axis. The dowel-cemented roots were sectioned at the coronal portion with a Diamond Wafering Blade 3" (76 mm; Buehler

metar od koronarnog dijela, a odrezani je dio bačen. Od svake trećine korijena – koronarne, središnje i apikalne – dobiveno je šest komadića debljine 1,00 ± 0,05 mm (2 reza po svakoj trećini). Svaki je na koronarnoj strani označen markerom, a njihova debljina provjerena je digitalnom pomičnom mjerkom točnosti 0,001 milimetar (Mitutoyo Sul Americana, São Paulo, SP, Brazil). Kako bi se obavio test istiskivanja svaki je uzorak postavljen s koronarnom stranom prema dolje u središte prstena od nehrđajućeg čelika s otvorom od tri milimetra centriranim na univerzalni uređaj za ispitivanje (Kratos Equipamentos Industriais Ltda., São Paulo, SP, Brazil) s brzinom glave od 0,5 mm/min. i opterećenjem od 1 KN. Ispitivani uzorak postavljen je na uređaj za testiranje i u središte glave od nehrđajućeg čelika i 1,0 milimetra i pažljivo je centriran na sredinu kolčića bez opterećenja okolnih stijenki. Opterećenje je primijenjeno na apikalnu stranu korijenskih rezova kako bi se izbjegao utjecaj koniciteta prostora oko kolčića. Kao točka pucanja veze korišten je vrhunac sile kod koje je počelo istiskivanje kolčića. Dobiveni rezultati u kgf-u prevedeni su u MP-a i raščlanjeni analizom varijance i Tukeyevim testom multiple varijance (LSMEANS) u podijeljenom polju i shemi faktorijala 6 x 2 x 3. Sve je analizirano u Windowsovu programu GraphPad Prism software v. 5,0 (GraphPad Software, San Diego, CA, SAD), a razina značajnosti bila je postavljena na pet posto.

Rezultati

Test protiskivanja za određivanje mikrosnage veze obavljen je na ukupno 540 dentinskih rezova. Srednje snage veze protiskivanja (MP-a) i standardna devijacija prema skupinama i trećinama korijena (otopinama za irigaciju) nalaze se u tablici 2. Grupa tretirana alkoholom (18,5 MP-a) i ona tretirana EDTA-om (8,6 MP-a) imale su najveću i najnižu srednju snagu protiskivanja. ANOVA je pokazala statistički značajnu razliku (p<0,0001) za čimbenik *otopine za irigaciju*, ali među trećinama korijena nije pronađena značajna razlika (p=0,0591) (tablica 3.).

U tablici 4. nalaze se zbrojene usporedbe po parovima šest eksperimentalnih i kontrolne grupe (fiziološka otopina) s pomoću Tukejeva i Dunnetova testa usporedbe. U grupi G 5 vezivanje je bilo najsnažnije i značajno se razlikovalo od svih ostalih, uključujući i kontrolnu. Grupe G 1, G 4 i G 6 nisu se značajno razlikovale i ni jedna se nije znatno razlikovala od kontrolne. Također nije nađena značajna razlika među grupama G2, G3, i G4 te se ni one nisu znatno razlikovale od kontrolne.

Srednje vrijednosti različitim slovima označavaju značajnu razliku pri 5 % (Tukeyev test; P < 0,05); *Grupe koje se statistički značajno razlikuju od kontrolne (Dunnetov test; P < 0,05).

Statistička analiza otkrila je da alkohol može značajno povećati snagu vezivanja kolčića za intrakanalni dentin. Gra-

Ltd., Lake Bluff, IL, USA) in a low-speed cutting machine (ELQUIP, São Carlos, SP, Brazil) under distilled water cooling. In each root, the first cut done at 1 mm from the most coronal portion of the root was discarded and 6 slices with thickness of 1.00 ± 0.05 mm were obtained from each tooth at the coronal, middle and apical root thirds (2 slices *per* third).

Each slice was marked on its coronal side with an indelible marker, and the thickness of the slices was checked by using a digital calliper accurate to the nearest 0.001 mm (Mitutoyo Sul Americana, São Paulo, SP, Brazil). For the push-out tests, each specimen was placed with its coronal side faced down on the centre of a stainless steel support with a 3-mm-diameter opening, which was connected to a universal testing machine (Kratos Equipamentos Industriais Ltda., São Paulo, SP, Brazil). The push-out tests were performed at a crosshead speed of 0.5 mm/min and using a 1 KN load cell. The push-out jig was placed on the test machine. Care was taken to centre the 1.0 mm-diameter stainless steel push-out pin on the centre of the dowel surface, without stressing the surrounding dowel space walls. The load was applied to the apical side of the root slice to avoid any limitation of dowel movement due to dowel space taper. The peak force at the point of extrusion of the dowel from the slice was taken as the point of bond failure. Data recorded in kgf were transformed into MPa and analyzed by analysis of variance and Tukey's multiple variation test (LSMEANS) in a split-plot design with a 6x2x3 factorial scheme. The GraphPad Prism software v. 5.0 for Windows (GraphPad Software, San Diego, CA, USA). A significance level of 5% was set for all analyses.

Results

A total of 540 root dentin slices were subjected to the micro push-out bond strength test. The push-out bond strength means (MPa) and standard deviations according to the groups and root canal thirds (irrigating solution) are presented in Table 2. The group treated with alcohol (18.5 MPa) and the group treated with EDTA (8.6 MPa) presented the highest and the lowest push-out bond strength means among all groups, respectively. ANOVA revealed statistically significant differences (p<0.0001) for the factor "*irrigating solution*", but no significant differences were found among the root thirds (p=0.0591) (Table 3).

Pairwise comparisons of the groups using the Tukey's test as well as comparison of the six experimental groups with the control group (saline) using the Dunnet's test are summarized in Table 4. G5 presented the highest bond strength and differed significantly from all groups, including the control group. G1, G4 and G6 did not differ significantly from each other and none of them was significantly different from the control group. In the same way, there was no significant difference among G2, G3 and G4, and they did not differ significantly from the control group.

Means followed by different letters indicate differ significantly at 5% (Tukey's test; P < 0.05); *Groups that present statistically significant differences from the control group (Dunnet's test; P < 0.05).

fički prikaz srednje snage protiskivanja i standardne devijacije pogledaj na slici 1.

The statistical analysis revealed that only alcohol was capable of increasing significantly the bond strength of dowel to intracanal dentin. The graphic presentation of the push-out bond strength means and standard deviations are presented in Figure 1.

Tablica 2. Srednje vrijednosti i standardne devijacije snage protiskivanja (MP-a) prema grupama (otopina za irigaciju) i korijenskim trećinama (C: koronarna; M: srednja; A: apikalna).
Table 2 Push-out bond strength means (MPa) and standard deviations according to groups (irrigating solutions) and the root canal thirds (C: coronal; M: middle; A: apical).

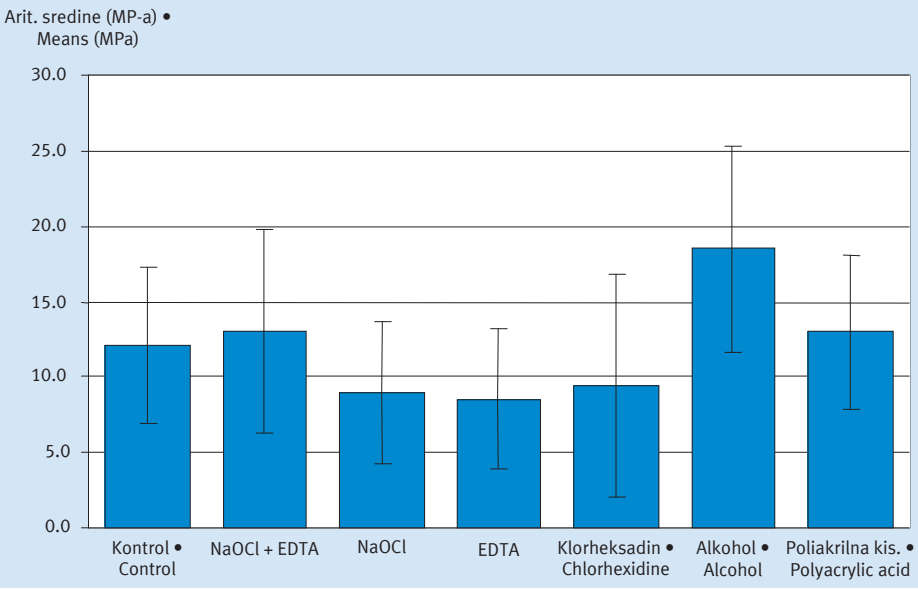
Grupa • Groups	Trećine korijenskih kanala • Root Canal Third	Arit. sredina/ trećine • Mean/Third	Arit. sredina / grupe • Mean/Group	SD
G1	C	14.4	13.1	6.7
	M	11.4		
	A	13.5		
G2	C	8.5	9.0	4.7
	M	9.8		
	A	8.7		
G3	C	8.3	8.6	4.7
	M	10.2		
	A	7.1		
G4	C	10.0	9.4	7.4
	M	10.3		
	A	8.0		
G5	C	20.5	18.5	6.9
	M	18.4		
	A	16.5		
G6	C	14.0	13.0	5.1
	M	14.3		
	A	10.6		
G7	C	14.2	12.1	5.2
	M	11.7		
	A	10.3		

Tablica 3. Analiza varijance srednjih vrijednosti za mikrosnagu protiskivanja
Table 3 Analysis of variance of the micro push out bond strength means.

Izvor varijacije • Source of Variation	Stupnjevi slobode • Degrees of Freedom	Zbroj kvadrata • Add of Squares	Sredina kvadrata • Mean Square	F	P vrijednost • P value
Tvar • Substance	5	215.5	43.10	25.39	P<0.0001
Trećina • Third	2	12.92	6.459	3.805	P=0.0591
Ostatak • Residue	10	16.97	1.697		
Ukupno • Total	17	245.4			

Tablica 4. Srednje vrijednosti i standardne devijacije (MP-a) snage protiskivanja, ovisno o otopini za irigaciju
Table 4 Push-out bond strength means (MPa) and standard deviations according to the irrigating solution.

Grupa • Groups	Srednje vrijednosti i SD • Means	
G5 (70% alkohol • alcohol)	18.5 ± 6.9*	A
G1 (5.25% NaOCl + 17% EDTA)	13.1 ± 6.7	B
G6 (poliakrilna kiselina • Polyacrylic acid)	13.0 ± 5.1	B
G4 (2% klorheksidinski gel • chlorhexidine gel)	9.4 ± 7.4	BC
G2 (5.25% NaOCl)	9.0 ± 4.7	C
G3 (17% EDTA)	8.6 ± 4.7	C
G7 (Kontrola • Control)	12.1 ± 5.2	



Slika 1. Aritmetičke sredine i standardne devijacije snage protiskivanja u eksperimentalnim i kontrolnoj grupi
Figure 1 Push-out bond strength means and standard deviations in the experimental and control groups

Rasprava

Endodontski liječeni zubi s velikom koronarnom destrukcijom mogu zahtijevati korištenje intraradikularnih kolčića kako bi se povećala retencija koronarnog restorativnog materijala (14).

Neke otopine unose se u prostor za kolčić prije cementiranja kako bi se očistio korijenski dentin i strugotine od instrumentacije te omogućila dodatna dekontaminacija. Intraradikularna adhezija velik je izazov zbog čimbenika koji ograničavaju uspostavljanje učinkovite veze između smola i korijenskog dentina. Ti čimbenici uključuju težak pristup pulpnoj komori i korijenskim kanalima, anatomske varijacije korijenskog dentina i stvaranje strugotina tijekom instrumentacije korijenskog kanala i pripreme za kolčić. Moguć je i utjecaj sastava korijenskog cementa za punjenje na sredstvo za cementiranje kolčića. Poteškoće pri polimeriziranju smolastih materijala u vrlo dubokim kavitetima su korištenje slabog sredstva za jetkanje koje nedovoljno uklanja strugotine i svojstva kolčića (15). Na dentinsku adheziju može utjecati i korištenje otopina za irigaciju te medikamentnih uložaka tijekom endodontske terapije (1, 2). U ovom istraživanju procjenjivao se učinak otopina za irigaciju pri čišćenju korijenskog kanala prije cementiranja fiberglasnih kolčića.

Grupa koja je bila irigirana NaOCl-om pokazala je najmanju snagu potrebnu za protiskivanje zajedno s EDTA-grupom, što se značajno razlikovalo od skupine tretirane alkoholom, NaOCl/EDTA-om i poliakrilnom kiselinom. NaOCl može smanjiti kvalitetu adhezije zbog zaostalog kisika koji stvara te tako inhibirati adhezivnu polimerizaciju. Taj učinak znatno varira, ovisno o sastavu adhezivnih sustava (3, 12). NaOCL uzrokuje i oštećenja organskog dijela dentina, uglavnom kolagena. To svojstvo može utjecati na dubinu prodiranja smolastih monomera kroz demineraliziranu strukturu (13). Kad se upotrebljavala samo EDTA dokazana je značajno smanjena mikročvrstoća dentina (16), što može uzrokovati promjene anorganskog matriksa korijenskog dentina, stvarajući demineralizirana područja (17). Dokazano je

Discussion

Endodontically treated teeth with great coronal destruction might require the use of intra-radicular dowels to increase the retention of the coronal restorative material[14].

Some solutions are applied into the dowel space prior to dowel cementation to promote for cleaning of root dentin, remove debris from instrumentation and provide additional decontamination. Intra-radicular adhesion involves great deal of challenge due to limiting factors for the establishment of an effective resin-root dentin bond. These factors include the difficult access to the pulp chamber and root canals; anatomic variations of the root dentin; smear layer formation during root canal instrumentation and dowel space preparation; probable influence of sealer composition on the luting agent used for dowel cementation; difficulty in polymerizing resin materials in extremely deep cavities; use of an weak etching agent, which would promote insufficient removal of smear layer; and influence inherent to dowel systems (15).

Dentin adhesion can be affected by the use of irrigating solutions and medications during the root canal treatment (1, 2). The influence of irrigating solutions used on root canal cleaning prior to cementation of fibre glass dowels was evaluated in the present study.

The group irrigated with NaOCl presented the lowest micro push out bond strength mean together with the EDTA group, differing significantly from the groups treated with alcohol, NaOCl/EDTA and polyacrylic acid. NaOCl can decrease the quality of the adhesion due to the presence of residual oxygen produced by this substance, inhibiting adhesive polymerization. However, this effect seems to vary according to the composition of the adhesive system (3,12).

NaOCl also cause damage to the organic components of dentin, mainly, collagen. This action may influence the penetration of resin monomers through the demineralized structure (13). The use of EDTA alone has been shown to considerably decrease dentin microhardness (16), and may promote alterations in the inorganic matrix of root dentin,

i da 15-postotna EDTA pri pH 7,3 nakon pet minuta stvara demineraliziranu zonu od 20 do 30 µm koja se pripisuje njezinu kelirajućem svojstvu (18). U nekim dosadašnjim istraživanjima uspoređivala se dubina demineralizacije različitih proizvođača kiselina za jetkanje, pa je ustanovljeno da nakon petnaest sekundi primjene tih sredstava, dubina demineralizacije varira od 0,5 do ,8 µm (19). Demineralizacija i deproteinizacija dentina olakšava prodiranje smolastih nastavaka u dentinske tubule i pridonosi jačim adhezivnim silama koje su ustanovljene kad je korištena *vlažna tehnika* postavljanja adheziva (12). Pretjerana demineralizacija, zbog irigacije kanala EDTA-om ili NaOCl-om, trebala bi se izbjegavati ako se namjeravaju rabiti samojetkajući sustavi jer se adhezija smanjuje ako se primjenjuju u kombinaciji s ovom otopinom (12). Kad se u ovom istraživanju upotrebljavao samojetkajući adhezivni cement, pretjerano jetkanje koje uzrokuje EDTA moglo je smanjiti snagu veze. To se događa zato što je dubina demineralizacije veća od difuzije impregnirajućeg cementnog monomera. Ako je dubina infiltracije manja od demineralizacijske dubine, ostaje zona ogoljelih i nepoduprtih kolagenih vlakana bez hidroksilapatita koja stoga kolabiraju, što onemogućuje infiltraciju adheziva u demineralizirani dentinski matriks i smanjuje vezivnu snagu. To područje golih kolagenih vlakana, neimpregniranih smolastim komponentama, može biti nestabilno i podložno hidrolizi te je u stanju kompromitirati adheziju (20). Dokazano je da 5,25-postotni NaOCl, bilo u kombinaciji s EDTA-om ili bez nje, smanjuje vezivnu snagu adheziva, što se ne uočava ako se korijenski kanali irigiraju 2-postotnim CHX-om u otopini ili gelu (21). Korištenje 5,25-postotnoga NaOCl-a, bilo u kombinaciji s EDTA-om ili bez nje, može uzrokovati promjene kolagenske mrežice (17). Unatoč tomu u ovom istraživanju je grupa s kombinacijom NaOCl-a i EDTA-e imala veću potrebnu snagu za protiskivanje kolčića, negoli ona u kojoj je korišten samo NaOCl.

Grupa tretirana CHX-om imala je srednje vrijednosti veze niže od kontrolne grupe (fiziološka otopina), premda bez statističke značajnosti. U nekim se istraživanjima ističe da sredstva za dezinfekciju, poput CHX-a, ne utječu na snagu veze za dentin (22, 23). Jetkanje fosfornom kiselinom, koje se primjenjuje u nekim protokolima adhezivnog vezivanja, može iz dentina ukloniti zaostale tvari nastale tijekom terapije korijena. U ovom istraživanju to se nije moglo uzeti u obzir jer korišteni samojetkajući sustav to ne zahtijeva. Zato, premda se u nekim istraživanjima navodi da CHX ne utječe na adheziju, neki stručnjaci tvrde da njegova 2-postotna primjena negativno djeluje na snagu vezivanja adhezivnih sustava na dentin (1, 24).

Jedna od velikih nada, kad je riječ o snažnijoj adheziji samojetkajućih sustava bila bi primjena poliakrilne kiseline kojom bi se mogle ukloniti nataložene sitne strugotine i pojačati adhezijska svojstva boljim prodiranjem u dentin. U ovom se istraživanju grupa tretirana tom kiselinom nije značajno razlikovala od kontrolne, iako je imala izmjerene nešto veće vezne sile. Primjena poliakrilne kiseline omogućuje dobar prikaz tubularne strukture, ali mogu ostati područja s nataloženim sitnim strugotinama i čepovima od strugotina jer je ta kiselina slabo agresivna i ne može potpuno očistiti zaostali

producing areas of demineralization (17). It has been reported that 15% EDTA at pH 7.3 after 5 minutes produced a 20- to 30-µm zone of demineralization, which is attributed to its chelating effect (18). A previous study compared the depth of demineralization of some commercial brands of acid etchants and found that the depth of demineralization varied between 0.5 and 5.8 µm, using an etching time of 15 s (19). Demineralization and deproteinization of dentin facilitate the penetration of resin tags into the dentin tubules and contribute to the higher adhesion forces observed when "wet bonding" technique was used[12]. However, excessive demineralization caused by irrigation of root canals with EDTA or NaOCl should be avoided when self-etch adhesives are intended to be employed, since there is a decrease of adhesion with the use of these substances (12).

Since the self-adhesive sealer used in this study *per se* has the capacity of promoting micromechanical retention to root dentin, over-etching produced by EDTA could decrease bond strength. This is because the extent of demineralization is deeper than the diffusion and impregnation of cement monomers. If the infiltration depth is less than the demineralization depth, a zone of hydroxyapatite-depleted collagen fibrils is left exposed and unsupported and collapses, preventing adhesive infiltration into the demineralized dentin matrix and compromising bond strength. This naked collagen zone which is not impregnated with resin components can be unstable and susceptible to hydrolysis, thus compromising adhesion (20).

It has been shown that 5.25% NaOCl combined or not with EDTA decreases the bond strength, which is not observed when root canals are irrigated with 2% CHX solution and gel (21). The use of 5.25% NaOCl alone or combined with 17% EDTA can promote alterations in the collagen mesh[17]. In spite of this, in the present study, the groups in which NaOCl was used in association with EDTA presented higher push-out bond strength than the group in which NaOCl was used alone.

The CHX group presented intermediate bond strength means, which were lower than those of the control group (saline) though without statistical significance. Some studies have shown that disinfecting agents such as CHX did not promote alterations in the shear bond strength to dentin (22, 23). Phosphoric acid etching, used in some bonding protocols, can remove products left by the chemical substances used on root dentin treatment. In the present study, it could not be taken into consideration because the self-etch sealer does not require this step. Therefore, although some studies have reported that CHX does not interfere on adhesion, others have claimed that the application of 2% CHX negatively affects shear bond strength of adhesive systems to dentin (1, 24).

One of the great expectations of increasing of the adhesion to root dentin with self-adhesive cements relied on the pretreatment with polyacrylic acid, which would have the capacity of removing the smear layer and improving the adhesion pattern by cement penetration into dentin. However, in the present study, the group treated with this acid did not differ significantly from the control group, in spite of

sloj (25), premda se smatra da ipak može ukloniti površinski *smear layer*. Kao slaba kiselina ne može stvoriti dovoljne promjene u pulpnom zidu (26), uglavnom zbog molekularne težine koja onemogućuje difuziju kroz dentinske tubule. Učinkovitost poliakrilne kiseline može se povezati s kapacitetom čišćenja, dovoljnim vlaženjem površine i mogućnošću kemijskog upijanja jer stvara kelacijski učinak (27). Zbog učinka čišćenja očekivalo se da će poliakrilna kiselina optimizirati djelovanje samojetkajućeg cementa i poboljšati adheziju, no to se nije dogodilo. Ovaj rezultat može se pripisati smanjenju površinske energije zbog izlaganja mineralnog dijela kalcija i fosfora s dentinske površine nakon djelovanja poliakrilne kiseline (28).

Važno je istaknuti da se, bez obzira na višu ili nižu istisnu snagu vezivanja kolčić – dentin, ni jedna grupa tretirana posebnim sredstvima za čišćenje nije značajno razlikovala od kontrolne (fiziološka otopina), osim one tretirane alkoholom. To sugerira da alkohol dovoljno povećava adheziju samojetkajućeg cementa Rely-XU100 za intrakanalni dentin, a da je ostale testirane otopine ne sprječavaju (0,2-% CHX, 17-% EDTA, 11,5-% poliakrilna kiselina, 5,25-% NaOCL i NaOCL + EDTA).

Najdublji dio postavljenih kolčića, na primjer, može patiti od nedovoljnog prodora svjetla i provođenja primjerene fotoaktivacije smolastog materijala, iako je u nekim istraživanjima istaknuto da je adhezija u dubljim trećinama slabija od one u koronarnoj trećini (12), no u ovom istraživanju nije nađena značajna razlika među trećinama korijena.

Zaključci

Korištenje 70-postotnog alkohola za čišćenje korijenskog kanala povećava snagu vezivanja fiberglasnog kolčića za intrakanalne dentinske zidove. Snaga istiskivanja između kolčića i korijenskog dentina nije se razlikovala prema trećinama (cervikalna, središnja i apikalna).

having higher bond strength values. The application of the polyacrylic acid produces a good visualization of the tubular structure, but dentin areas with smear layer and smear plugs can be left because the polyacrylic acid is little aggressive and does not have the capacity of removing the debris completely (25), though its smear layer removal capacity is considered efficient. As a weak acid, it cannot produce significant pulpal alterations (26), mainly because of its high molecular weight, which hinders its diffusion through the dentin tubules. The efficacy of polyacrylic acid can be related to its capacity of cleaning, producing adequate surface moistening and being chemically absorbed, promoting chelating effect (27). Because of its cleaning action, it was expected that the polyacrylic acid would optimize the self-etch action promoted by the cement, improving the adhesion, which, however, did not occur. This result might be attributed to a decrease of surface energy due to exposure of the mineral portion of Ca and P from dentin surface by the action of polyacrylic acid (28).

It is important to emphasize that, regardless of the higher or lower dowel-dentin push bond strength means; none of the groups treated with the different cleaning solutions differed significantly from the control group (saline), except for the group treated with alcohol. Therefore, it is assumed that the use of alcohol alone was capable of increasing the adhesion of the self-adhesive resin cement Rely-X U100 to the intracanal root dentin and that all other tested solutions (0.2% CHX, 17% EDTA, 11.5% polyacrylic acid, 5.25% NaOCl and NaOCl + EDTA) did not interfere with the adhesion.

The deepest areas of the dowel space, for example, may suffer influence from the difficulty of performing adequate photoactivation of the resin materials. Although previous studies have shown that adhesion in deeper thirds is lower than that in the coronal third (12), no significant difference among the root thirds was observed in the present study.

Conclusions

The use of 70% alcohol for cleaning of the root canal system increased the bond strength of the fibre glass dowel to the intracanal dentin walls; The push-out bond strength between the dowel and the root dentin was not affected by the root third (cervical, middle and apical).

Abstract

Purpose: To evaluate the effect of different endodontic irrigating solutions on the micro push-out bond strength of a fiber glass dowel. **Material and Methods:** Seventy 16-mm long root segments of bovine incisors were prepared and randomly assigned to 7 groups (n=10) according to the type of irrigating solution used prior to the cementation of the intra-radicular fiber glass dowels: G1: 5.25% NaOCl + 17% EDTA; G2: 5.25% NaOCl; G3: 17% EDTA; G4: 2% chlorhexidine gel; G5: 70% alcohol; G6: 11.5% polyacrylic acid; and G7: saline (control). After treatment of intracanal dentin, the glass fibre dowels were cemented with self-adhesive resin cement (RelyX Unicem). Six slices with the thickness of 1.00 ± 0.05 mm were obtained from each tooth at the coronal, middle and apical root thirds (2 slices *per* third) using a low-speed saw. Micro push-out tests were performed at a crosshead speed of 0.5mm/min and the data (MPa) were analyzed statistically by ANOVA and Tukey's and Dunnett's tests. **Results:** There were statistically significant differences (p<0.0001) among the irrigating solutions, but no significant difference (p=0.0591) was found among the root thirds. G5 presented the highest bond strength mean of all groups (p<0.0001). The use of 70% alcohol increased the adhesion values by 53% compared to the group control. **Conclusion:** The use of 70% alcohol increased the bond strength of the fiber glass dowel to the dentin walls. However, the push-out bond strength between the dowel and the root dentin was not affected by the root third (coronal, middle and apical).

Received: June 16, 2013
Accepted: January 30, 2014

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Key words
Tensile Strength; Post and Core Technique; Root Canal Irrigants

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