NAUČNI RAD
SCIENTIFIC ARTICLE

IN VITRO KOMPARACIJA SNAGE VEZIVANJA IZMEĐU DVA KOMPOZITA ZA GLEĐ I DENTIN UPOTREBOM ADHEZIVA EXITE®

IN VITRO COMPARATION OF SHEAR BOND STRENGTH OF TWO RESIN COMPOSITE TO ENAMEL AND DENTINE USING EXCITE® AS AN ADHESIVE

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Kratak sadržaj

Cilj ovog rada je komparacija snage vezivanja između tvrdih zubnih tkiva (gleđ i dentin) i dva tipa kompozita, upotrebom Excite adheziva. Prvi kompozit Tetric Ceram je odgovarajući tj. kompatibilan sa Excite adhezivom, a drugi kompozit Charizma® je nekompatibilan sa istim adhezivom. Za izradu eksperimenta upotrebili smo humane, intaktne, trajne zube, koji su ekstrahirani zbog ortodontskih i paradontopatičnih razloga. 60 nekarioznih zuba podelili smo u tri grupe u odnosu na eksponiranu površinu. I grupa: eksponiran gleđ na okluzalnoj površini, II grupa eksponiran dentin na okluzalnoj površini i III grupa eksponiran gleđ i dentin. Polovini primeraka iz svake grupe aplicirali smo Excite adheziv i Tetric Ceram® kompozit, a drugoj polovini Excite® i Charizma® kompozit. Rezultate smo obradili standardnim statističkim metodama. Kombinacija Excite adheziva i Tetric Ceram kompozita pokazala ja signifikantno jaču snagu vezivanja, od kombinaciju Excite-Charizma®.

Ključne reči: *Excite, adheziv, gleđ, dentin, kompozit*

Abstract

The purpose of this study was to compare shear bond strength between hard dental tissue- enamel and dentin- and two types of resin composites, using Excite® adhesive. The first one, resin composite - Tetric® Ceram® is adequate i.e. compatible to Excite, the other composite - Charisma® is incompatible. We used 60 healthy human permanent teeth - carious free, divided in three groups prepared: with enamel oclusal surface, with dentine oclusal surface and enamel-dentine oclusal surface. Half of the specimens in each group were coated with Excite and Tetric Ceram®, and the other half were coated with Excite® and Charisma®. The interfacial bond strength of these specimens was measured in shear. The results were evaluated with standard statistics methods. Excite - Tetric Ceram® combination showed significantly higher bond strength than Excite - Charisma® combination.

Key words*: Excite, adhezive, email, dentin, composite*

Uvod

Smatra se da je adhezija kompozitnih smola za dentalna tkiva najvažniji faktor za poboljšanje veze između restauracija i zuba [1,2,3,4].

Introduction

Adhesion of composite resins to dental tissues is considered to be the most important factor for improving the bond between the restoration and the tooth[1,2,3,4].

Nagrizanje i bondiranje gleđi je godinama najsigurniji i najjednostavniji postupak. U toku nagrizanja, kiselina stvara prizmatske i interprizmatske nepravilnosti, u kojima kompozitna smola ostvaruje mehaničku retenciju posle polimerizacije. Demineralizacija gleđi zavisi od pH kiseline i od vremena trajanja nagrizanja, koje treba biti dovoljno dugo da bi obezbedilo adekvatnu retenciju u gleđi[5,6]. Ako se ne koristi fosforna kiselina za nagrizajući, ili ako se koristi samonagrizajući prajmer, veza sa gleđ je manje efikasna.

Efikasni bonding mehanizmi se postižu kada je razmazani sloj (smear leyer) sasvim rastvoren, takođe i intertubularni i peritubularni dentin, kolagena vlakna eksponirana i kada se posle infiltracije kompozitnih monomera formira hibridni sloj. Ovakav bonding mehanizam je evidentan u gleđi i dentinu od četvrte do šeste generacije bonding sistema[7,8].

Jedan od osnovnih faktora za determinaciju adhezije između čvrstih dentalnih tkiva (gleđi i dentina) i kompozitnih smola je određivanje jačine vezivanja[9,3].

Mnogi autori su prikazali snagu vezivanja dentina sa kompozitima pri upotrebi "one bottle" adhezive[10,11,12,13]. Jang[5] je randomizirao zube u četiri grupe, a svaka grupa je bila tretirana sa različnim adhezivnim sistemom. Rezultati koje je dobio bili su u rasponu od 24,39 do 30,82 MPa.

Asmussen i Munksgaard[14] su ispitivali jačinu adhezivne veze između strukture zuba i kompozita. Vrednosti snage vezivanja su bile oko 18 MPa, što se smatra dovoljnim za balansiranje sile kontrakcije u toku polimerizacije kompozita da bi se veza održala stabilnom.

Ivanović[15,16,17] je u svom ispitivanju dobio značajno niže vrednosti za adhezivnu vezu, testirajući adhezivne sisteme sa inkopatibilnim kompozitima.

For many years etching the enamel and bonding to it is a safe procedure. During etching, acid produces interprismatic and prismatic irregularities into which resin can create mechanical retention after polymerisation. The demineralisation of the enamel depends on pH of the acid and the etching time, which needs to be sufficient to provide adequate enamel retention.[5,6] When phosphoric acid is not used, or when self-etching primers are used, the bonding to enamel is less effective.

Effective bonding mechanism can be achieved when the smear layer is completely dissolved, intertubular and peritubular dentin is dissolved, collagen fibres exposed, and after infiltration of resin monomers, a hybrid layer is formed. This bonding mechanism is evident from fourth to sixth generation of enamel dentin bonding systems.[7,8]

One of the basic factors to determine adhesion between hard dental tissues - enamel and dentine and composite resins is measuring the shear bond strength.[9,3]

Many authors evaluated the shear bond strength to dentin of pack able composites using their respective one-bottle adhesives.[10,11,12,13] In his investigations Jang[5] randomised and distributed the teeth in four groups, and each group treated with a different adhesive system. Shear bond strength results varied from 24,39 to 30,82 MPa.

Asmussen and Munksgaard[14] investigated the strength of the adhesive link between the tooth structure and the composite. The shear bond strength was 18 MPa, which was considered to be enough to balance the shrinkage during composite polymerisation and to keep the link stable.

Ivanovic[15,16,17] found significantly lower shear bond strength while testing adhesive systems that included incompatible composites.

Materijal i metod

Za ostvarivanje cilja ove studije upotrebili smo 60 humanih, intaktnih zuba. Svi zubi su bili nekariozni, ekstrahirani iz ortodontskih i paradontopatičkih razloga i čuvani u 9%-om fiziološkom rastvoru na temperaturi od 4°C. Zube smo po slučajnom izboru podelili u tri grupe od po

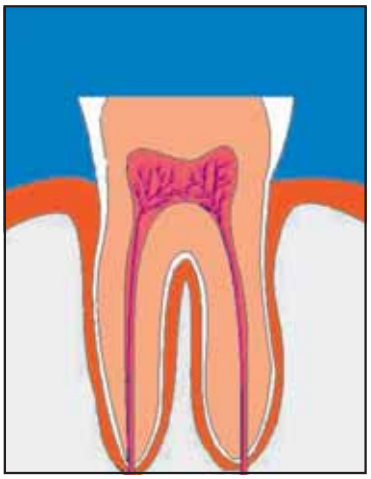
Material and method

Sixty human, carious-free teeth, extracted because of orthodontic and paradontho-pathic reasons, were used in this study. Immediately after extraction the teeth were stored in saline solution 0,9%, on the temperature of 40C. Teeth were randomly divided in three groups, each consisted of 20 teeth. Specimens from the

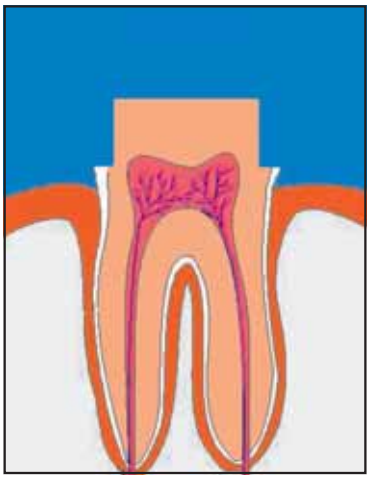
20. Uzorci zuba iz prve grupe, preparirani su paralelno sa okluzalnom površinom eksponirajući superficijalni gleđ (Sl. 1). Zube iz druge grupe smo preparirali tako da se eksponira gleđ i dentin (Sl. 2), a zube iz treće grupe smo isprepparirali cirkularno da bi odstranili gleđ i eksponirali samo dentin (Sl. 3).

first group were sectioned parallel to the occlusal surface to expose superficial enamel (Fig.1). Teeth from the second group were prepared to expose enamel and dentine surface (Fig. 2). Specimens from the third group were sectioned transversally and circularly in order to remove enamel, and expose dentin surface only (Fig 3).

Slika 1.
Figure 1.



Slika 2.
Figure 2.



Slika 3.
Figure 3.

Sve površine su kondicionirane sa 37% fosfornom kiselinom i premazane Excite adhezivom prema uputstvima proizvođača. Polovinu zuba iz svake grupe smo spojili sa Tetric Ceram kompozitom, a drugu polovinu sa Charisma kompozitom. Prema uputstvu proizvođača Tetric Ceram je kompatibilan sa Excite adhezivom, dok Charisma pripada sasvim drugačijem adhezivnom sistemu. Svaki zub je pričvršćen za metalni držač i postavljen prema drugim, koji je isto tako fiksiran na metalni držač. Zubi iz svakog para su spojeni sa adhezivom i kompozitom. Određivanje snaga vezivanja svakog zubnog para je izvedeno pomoću servo-hidraulične mašine za mehaničko testiranje – Instrom, sa stopom za odstranjivanje od 2 mm/min (Sl. 4).

U trenutku debondiranja zubnih parova merili smo jačinu opterećenja, a dobijene vrednosti smo podelili sa površinom preparirane okluzalne površine, prema formuli $\tau = F/A$ ($N/mm^2 = MPa$)*. Dobijene vrednosti za zubne uzorke, tretirane Excite adhezivom i Tetric Ceram kompozitom uporedili smo sa vrednostima dobijenih od uzoraka tretiranih sa Excite adhezivom i Charisma kompozitom.

All surfaces were etched with 37% Phosphoric acid. After that we coated Excite according to manufacturer's instruction. Half of the teeth (10 from each group) were restored with Tetric Ceram, and the other half (10 from each group) with Charisma. Tetric Ceram is compatible with Excite according to manufacturer's recommendations, but Charisma belongs to a different adhesive system. Each specimen was fixed on a metal holder and placed against another specimen on a metal holder. Specimens from the pair were connected with composite and adhesive. Shear bond testing of the specimens was performed on servo-hydraulic mechanical testing machine – Instrom, with a displacement rate of 2 mm/min (Fig. 4).

At the point where the specimens were de-bonded, we measured the shear bond strength, and made calculation with the formula $\tau = F/A$ ($N/mm^2 = MPa$)*. Obtained values for the specimens treated with Excite and Tetric Ceram were compared with the values obtained for the specimens, which were coated with Excite and restored with Charisma.

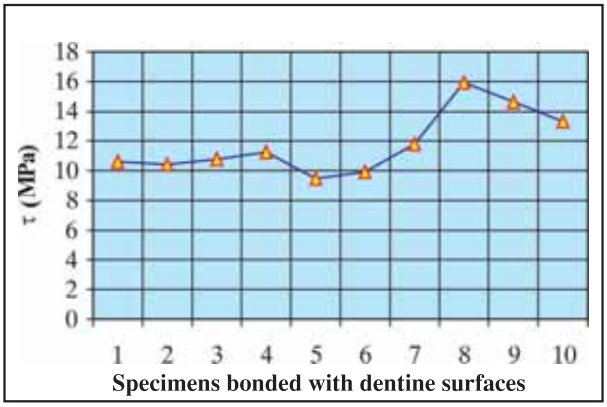
Rezutati

Rezultati srednje vrednosti (0) za jačinu vezivanja zuba tretiranih sa Excite i Tetric Ceram prikazani su na Graf. 1, 2 i 3. Rezultati srednje vrednosti (0) za snagu vezivanja zuba tretirani sa Excite i Charismom prikazani su na Graf. 4, 5 i 6.

Results

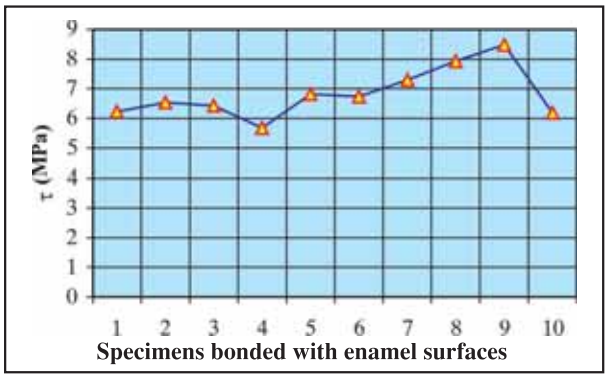
Results of the mean value (0) of the shear bond strength of specimens treated with Excite - Tetric Ceram are shown on Graphic 1, 2 and 3. Results of the mean value (0) of the shear bond strength for specimens treated with Excite - Charisma are shown on Figure 4, 5 and 6.

Slika 4.
Figure 4.



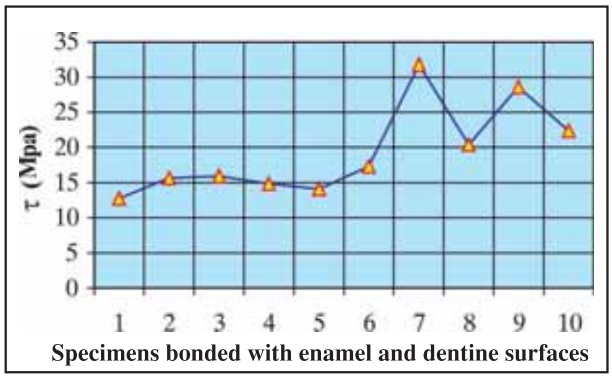
Grafikon 1. Uzorci bondirani na dentinskim površinama
Graphic 1. Specimens bonded with dentine surfaces

$\overline{X}$ = 11,81 MPa



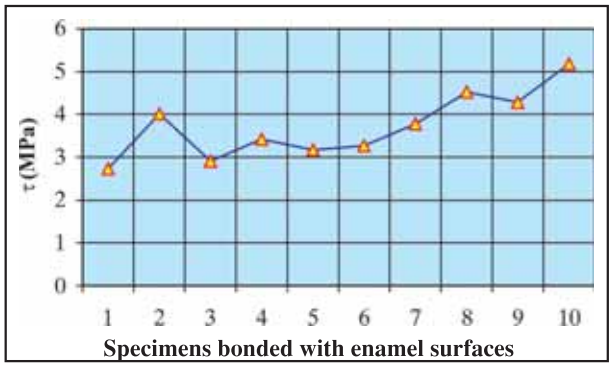
Grafikon 2. Uzorci bondirani na gleđnim površinama
Graphic 2. Specimens bonded with enamel surfaces

$\overline{X}$ = 6,82 MPa



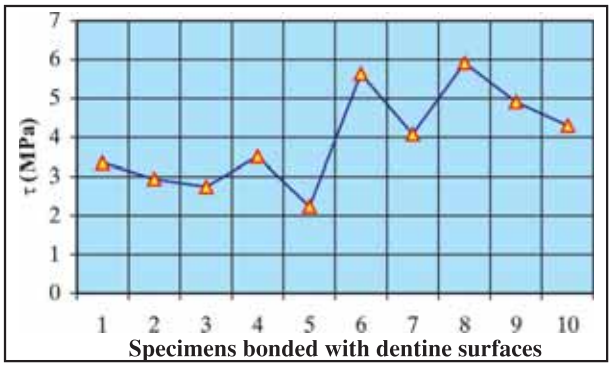
Grafikon 3. Uzorci bondirani na gleđnim i dentinskim površinama
Graphic 3. Specimes bonded with enamel and dentine surfaces

$\overline{X}$ = 19,37 MPa



Grafikon 4. Uzorci bondirani na gleđnim površinama
Graphic 4. Specimens bonded with enamel surfaces

$\overline{X}$ = 11,81 MPa

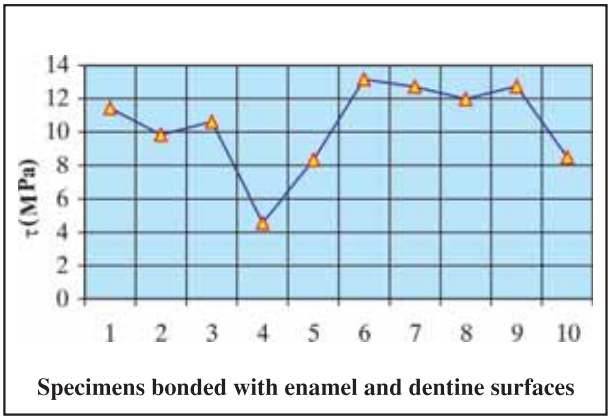


Grafikon 5. Uzorci bondirani na dentinskim površinama
Graphic 5. Specimens bonded with dentine surfaces

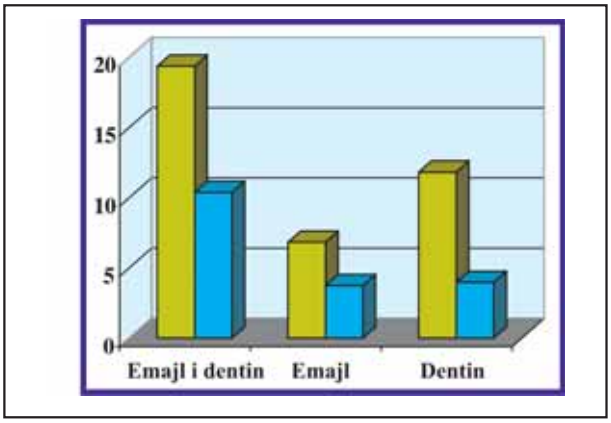
$\overline{X}$ = 3,95 MPa

Za statističku analizu podataka korišćeni su Student t-test i Welch - test. Kompratívne vrednosti između dva adhezivna sistema prikazane su na tabelama 1, 2, 3 i grafikonu 7.

Student- t test and Welch- test were used for statistical analysis. Comparative values between two adhesive systems are shown on the table 1, 2, 3, and figure 7.



Grafikon 6. Uzorci bondirani na gleđnim i dentinskim površinama
Graphic 6. Specimens bonded with enamel and dentine surfaces



Grafikon 7.
Graphic 7.

Kompatibilan adehzivan sistem:
Excite – Tetric Ceram

Compatible adhesive system:
Excite – Tetric Ceram

Nekompatibilan adehzivan sistem: Excite – Charisma

Incompatible adhesive system
Excite – Charisma

Tabela 1. Uzorci bondirani na gleđnim površinama / *Table 1*. Specimens bonded with enamel surfaces

	$X_3PO_4 \Rightarrow$ Excite $\Rightarrow$ Tetric Ceram	$H_3PO_4 \Rightarrow$ Excite $\Rightarrow$ Charisma
X	**6.8280**	**3.7270**
SD	**0.8090**	**0.7351**
t	**8.9712849**	
Welch	**8.9712858**	
p	**< 0.001**	

Tabela 2. Uzorci bondirani na dentinskim površinama / *Table 2*. Specimens bonded with dentine surfaces

	$X_3PO_4 \Rightarrow$ Excite $\Rightarrow$ Tetric Ceram	$H_3PO_4 \Rightarrow$ Excite $\Rightarrow$ Charisma
X	**11.8150**	**3.9590**
SD	**2.0205**	**1.1726**
t	**10.6341400**	
Welch	**10.6341410**	
p	**< 0.001**	

Tabela 3. Uzorci bondirani na gleđnim i dentinskim površinama
Table 3. Specimens bonded with enamel and dentine surfaces

	$X_3PO_4 \Rightarrow$ Excite $\Rightarrow$ Tetric Ceram	$H_3PO_4 \Rightarrow$ Excite $\Rightarrow$ Charisma
X	**19.3720**	**10.3790**
SD	**6.1141**	**2.5362**
t	**4.2962928**	
Welch	**4.2962923**	
p	**< 0.001**	

Parovi uzoraka bondirani sa kompatibilnim adhezivnim sistemom na gleđnim površinama pokazali su statistički veću snagu vezivanja od parova zuba bondiranih sa inkopatibilnim adhezivnim sistemom.

Zubni parovi bondirani za gleđ i dentin pomoću kompatibilnih adhezivnih sistema pokazali su signifikantno veću snagu vezivanja nego zubni parovi bondirani sa inkopatibilnim adhezivnim sistemom.

Zubni parovi bondirani za dentin sa kompatibilnim adhezivnim sistemom pokazali su signifikantno jaču snagu vezivanja nego zubni parovi bondirani inkopatibilnim adhezivnim sistemom.

Diskusija

Najbolji način za postizanje realne i kompletne slike o jačini veze između kompozitnih materijala sa jedne, i zubnih tkiva (gleđ, dentin), sa druge strane, je određivanje snage vezivanja. Ova vrsta testova se izvodi u in vitro uslovima i smatra se pouzdanom za evaluaciju adhezivne veze između zuba i materijala. Veliki broj laboratorijskih kao i kliničkih ispitivanja su dokazala važnost praćenja uputstva za upotrebu koje preporučuje proizvođač, da bi se dobili najbolji rezultati.

U toku ispitivanja, različiti adhezivni sistemi su pokazali različite vrednosti za jačinu vezivanja. Razlog bi mogao biti u hemijskim i fizičkim razlikama kod različitih adhezivnih sistema, koji su korišćeni, kao i u vezi koju oni ostvaruju sa tkivom gleđi i dentinom.[15,17]

Pairs of specimens that were bonded with compatible adhesive system on an enamel surfaces showed significantly higher shear bond strength, than the pairs of specimens bonded with incompatible adhesive systems on enamel surfaces.

Pairs of specimens that were bonded with compatible adhesive systems on enamel and dentin surfaces showed significantly higher shear bond strength, than the pair of specimen bonded with incompatible adhesive systems on enamel and dentin surfaces.

Pairs of specimens that were bonded with compatible adhesive systems on dentin surfaces showed significantly higher shear bond strength, than the pair of specimen bonded with incompatible adhesive systems on dentin surfaces.

Discussion

The best way to obtain a realistic and comprehensive picture about the strength of the connection between the composite material on one side, and the enamel and dentin on the other, is to measure the shear bond strength. These kinds of test are performed in vitro conditions and are considered to be reliable in evaluating. The adhesive connection between the tooth and the material. Great number of laboratory investigations, as well as clinical, are in favour of following the instructions for use from the manufacturer in order to obtain best results.

Different adhesive systems showed different values for the shear bond strength when investigated. The reason could be the difference in the chemical and physical properties of the adhesive systems that were used and the connection they made with the hard dental substances.[15,17]

Praćenje kompletnog postupka koji uključuje: kondicioniranje gleđi dentina, zatim upotreba adhezivnih sistema i kompozitnih materijala, je važan korak u postizanju dobrih rezultata, ali ne i dovoljan.[8,3] Veoma ja važna upotreba adhezivnih sistema u kombinaciji sa kompatibilnim kompozitnim materijalima po preporuci proizvođača[4]. Jedan od razloga za slabu vezu između materijala za ispune i zuba mogla bi biti upotreba adhezivnog sistema koji nije kompatibilan sa upotrebljenim kompozitom.

Ovo bi ujedno moglo biti objašnjenje i za rezultate dobijene u našim ispitivanjima. Kada smo u toku rada postupali po preporukama proizvođača i koristili kompatibilne adhezivne sisteme, rezultati su pokazali signifikantno jaču vrednost za snagu vezivanja.

Following the complete procedure that includes etching the enamel and the dentin, than using adhesive systems and composite material is an important step for achieving good results, but not enough.[8,3] It is very important to use adhesive systems in combination with compatible composite materials as recommended by the manufacturer.[4] One of the reasons for poor bonding between the filing material and the tooth could be the use of an adhesive system with incompatible composite material.

This could explain the result from our study: when we followed the recommendation of the manufacturer and used compatible adhesive systems to bond enamel, dentin and enamel and dentin surfaces, the results demonstrated significantly higher values for shear bond strength, compared with the group were we used incompatible adhesive systems.

Zaključak

Upotreba isključivo kompatibilnih adhezivnih sistema, strogo po preporuci proizvođača, signifikantno povečava jačinu veze između zubnih tkiva i adhezivnih materijala.

Conclusion

Using strictly compatible adhesive systems and following the instruction for use as recommended, significantly improves the strength of the bond between dental tissues and composite material.

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