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Sanja Jurišić[1], Gordan Jurišić[1], Hrvoje Jurić[2]

Utjecaj adheziva i postupaka pripreme cakline na smičnu snagu vezivanja ortodontskih bravica

Influence of Adhesives and Methods of Enamel Pretreatment on the Shear Bond Strength of Orthodontic Brackets

[1] Stomatološka poliklinika Jurišić, Mostar, Bosna i Hercegovina
Dental Polyclinic Jurišić, Mostar, Bosnia and Herzegovina
[2] Stomatološki fakultet Sveučilišta u Zagrebu, Hrvatska
School of Dental Medicine, University of Zagreb, Croatia

Sažetak

Svrha: Ovim se istraživanjem željelo ispitati kakav je utjecaj adheziva i postupaka pripreme cakline na smičnu snagu vezivanja (engl. shearbondstrenght – SBS) ortodontskih bravica. Korišteni adhezivi bili su smolom ojačani staklenoionomerni cement (engl. glassionomer cement – GIC; Fuji Ortho LC) i kompozitna smola (Transbond XT). **Ispitanici i postupci:** Eksperimentalni uzorak činilo je 80 ekstrahiranih prvih humanih pretkutnjaka, tj. premolara. Uzorak je bio podijeljen u četiri skupine, pa su metalne bravice lijepljene nakon različitih priprema cakline, a koristili smo se dvjema vrstama adheziva: u skupini A. 10-postotnom poliakrilnom kiselinom i Fuji Ortho LC-om; u skupini B: 37-postotnom ortofosfornom kiselinom i Fuji Ortho LC-om; u skupini C: samojetkajućim primerom (engl. self-etchingprimer – SEP) i Transbondom XT, u skupini D: 37-postotnom ortofosfornom kiselinom, primerom i Transbondom XT. Mjerena je SBS bravica. Nakon skidanja bravica određivao se indeks za procjenu preostaloga materijala na površini cakline (engl. AdhesiveRemnant Index – ARI). **Rezultati:** Nakon statističke analize podataka (ANOVA; Sheffeov post-hoc test) rezultati su pokazali značajno manji SBS u skupini B u odnosu na skupine C ($p = 0,031$) i D ($p = 0,026$). Rezultati za ARI bili su slični u svim ispitivanim skupinama i nije bilo moguće utvrditi statistički značajnu razliku za procjenu preostaloga materijala na površini cakline (Hi-kvadrat test) između svih četiriju skupina. **Zaključak:** Možemo zaključiti da je uporaba kompozitnih smola, nakon odgovarajuće pripreme cakline prema uputama proizvođača, *zlatni standard* u vezivanju bravica u fiksnoj ortodonciji.

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Adresa za dopisivanje
Prof. dr. sc. Hrvoje Jurić
Sveučilište u Zagrebu
Stomatološki fakultet
Zavod za dječju i preventivnu stomatologiju
10 000 Zagreb, Gundulićeva 5
tel: 1 4802 111
juric@sfzg.hr

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Uvod

Fiksnim ortodontskim napravama koristimo se u suvremenoj ortodontskoj terapiji od 70 do 80 posto slučajeva. Fiksna ortodoncija nezamisliva je bez adhezivnih materijala i stakloionomernih cemenata (engl. glassionomer cement – GIC). Ranih 50-ih godina 20. stoljeća u stomatologiju se pionirski uvode adhezivni materijali. Slijedio je daljnji razvoj dentalnih adheziva, što je omogućilo njihovu širu uporabu i u fiksnoj ortodonciji (1). U ortodonciji se kao adhezivi uglavnom upotrebljavaju slabo punjeni ili nepunjeni Bowenovi esteri. Primeri su najčešća kemijska sredstva koja se primjenjuju u monomolekularnom sloju na površini materijala, mijenjajući njegova svojstva za osiguravanje bolje adhezije. Veza između cakline i adheziva postiže se mehanički, a temelji se na geometrijskoj hrapavosti površine i stvaranju mikropora te na reološkom učinku koji se pojavljuje pri prelasku adheziva iz tekućega u čvrsto stanje (2).

Introduction

Fixed orthodontic appliances are used in modern orthodontic treatment in about 70-80% of cases. Fixed orthodontics is unthinkable without adhesive composite resin materials and glass ionomer cements (GIC). In the early 1950s, a pioneering introduction of adhesive materials in dental medicine took place. This was followed by further development of dental adhesives, enabling their use also in fixed orthodontics (1). Unfilled Bowen's ethers, or ethers with small filler content, are mainly used in orthodontics as adhesives. Primers are most often the chemical agents applied in a monomolecular layer on the surface of the material to be bonded, changing its properties in order to provide better adhesion. The bond between enamel and adhesive is achieved by mechanical bonding based on geometric surface roughness and creation of micro pores, as well as by rheological effect that occurs when adhesive changes from fluid to solid (2).

Ortodontski adhezivi

U ortodonciji se kao adhezivi uglavnom upotrebljavaju dvokomponentne kompozitne smole. Kontakt dviju komponenti potiče reakciju polimerizacije. Razvojem adheziva nastali su i MIP materijali (eng. Moisture Insensitive Primer). Oni sadržavaju hidrofilni primer koji se otapa u acetonu, a preporuka je da se koristi na lagano vlažnoj kondicioniranoj caklini (3).

Staklenoionomerni cementi (GIC)

Prve staklenoionomerne cemente opisali su Smith i Wilson (4), a dobivaju se miješanjem praškaste baze i vodene otopine kiseline (kalcijsko fluoro aluminijskoga silikatnog praha i poliakrilne kiseline). Osnovna kemijska reakcija tijekom polimerizacije cementa je neutralizacija između tekućine (kiselina) i praha (baza), što rezultira stvaranjem soli (stvrdnuti GIC) i vode (1,5).

Modificirani GIC

Nastojeći poboljšati kemijska i mehanička svojstva cemenata, u sastav su im dodavani različiti dodatci, poput amalgama i srebra. Najvažniji dodatak GIC-a, s aspekta njihove evolucije, jesu smole. Smole su se dodavale kako bi se poboljšala mehanička i estetska svojstva te pojačala adhezija i zadržavanje otpuštanja fluorida. Navedeni materijali uspjeli su donekle riješiti većinu problema tijekom postavljanja bravica u fiksnoj ortodonciji (6).

Najčešći klinički problemi i dalje su odljepljivanje bravica, bijele mrlje (rana karijesna lezija) i niska otpornost adhezivnih materijala na vlagu prije polimerizacije (7, 8, 9, 10, 11). Ortodontski adheziv trebao bi omogućiti vezivanje bravice za caklinu tijekom ortodontske terapije i njezino uklanjanje kada bude potrebno, a da se ne ošteti caklinska površina i da pacijent nema neugodnosti (12). Rezultati istraživanja pokazuju da razvoj novih materijala i korištenje novih tehnika čine kliničke metode jednostavnijima i uspješnijima (13). Istraživanja pokazuju da se materijali upotrebljavaju uz različite metode pa je njihova procjena i usporedba ograničena (14). Svrha ovog istraživanja bila je ispitati smičnu snagu vezivanja (SBS) ortodontskih bravica na caklinsku površinu s obzirom na način njezine pripreme te vrstu korištenog adhezivnog materijala. Nakon skidanja bravica željeli smo odrediti količinu preostaloga adhezivnog materijala na površini zuba. Nulta hipoteza glasila je da vrsta adhezivnog materijala utječe, a način pripreme cakline ne utječe na SBS bravica na caklinsku površinu.

Materijali i metode

U eksperimentalne skupine bilo je uvršteno 80 prvih humanih pretkutnjaka, tj. premolara obiju čeljusti, ekstrahiranih iz ortodontskih razloga. Vestibularna površina svih zuba bila je intaktna, bez karijesa i frakturnih linija. Nakon vađe-

Orthodontic composite resin adhesives

Two-component composite resins are mainly used as adhesives in orthodontics. A contact of two components causes polymerization reaction. Nowadays, the adhesive MIP (Moisture Insensitive Primer) materials are being developed. They contain hydrophilic primer that dissolves in acetone, and the recommendation is to use it on a slightly moist conditioned enamel (3).

Glass ionomer cements (GIC)

First GIC were described by Smith and Wilson (4). They are prepared by mixing of powder and water solution of acid (Ca-fluoroaluminosilicate powder and polyacrylic acid). The basic chemical reaction during cement polymerization is neutralization between fluid (acid) and powder (base), which results in creation of salt (polymerized GIC) and water (1, 5).

Modified GIC

In an attempt to improve chemical and mechanical properties of cements, various additives were added to them, such as amalgam or silver. The most important additives to GIC from the aspect of their evolution are resins. Resins were added in an attempt to improve mechanical and aesthetic qualities, along with increasing adhesion and preserving fluoride release capacity. These materials were able to solve most of the problems in brackets bonding during fixed orthodontics treatment (6).

The most common clinical problems are still bracket debonding, emergence of early carious lesions (white spots) and low resistance of adhesive materials to moisture prior to the polymerization (7, 8, 9, 10, 11). Orthodontic adhesive should be appropriate for allowing bracket to stay bonded to the enamel surface during the orthodontic therapy and also, to allow simple bracket removal when it is needed, but with no signs of damaging to enamel and without discomfort for patients (12). Research-based findings have constantly led to the development of new materials and usage of new techniques that are aimed at simplifying the clinical procedures (13). Different studies have already been conducted concerning the usage of almost all these materials but always with different procedures, therefore the evaluation and the comparison are limited (14). The purpose of the present study was to examine the shear bond strength (SBS) of orthodontic brackets to enamel surface with respect to the type of adhesive material used and enamel pretreatment. After brackets debonding, we also wanted to analyze the amount of remaining adhesive material on tooth surface. The null hypothesis was that the type of adhesive material has impact on SBS of brackets to enamel surface, while methods of enamel pretreatment have no impact on SBS of brackets to enamel surface.

Materials and methods

Experimental groups consisted of 80 human first premolars of both jaws that had been extracted due to orthodontic reasons. The buccal enamel surface of all teeth was intact, without caries lesions and macroscopic visible frac-

nja sa zuba je uklonjena nečistoća, a zatim je opran vodom iz slavine. Vestibularna površina očišćena je rotirajućom sintetičkom četkicom, laganim pokretima ruke. Zubi su dezinficirani 24 sata u 0,1-postotnoj (specifični volumen) otopini timola. Svi su uzorci bili uronjeni u destiliranu vodu maksimalno četiri mjeseca prije testiranja, a mijenjala se svaki tjedan. Svi donatori zuba potpisali su informirani pristanak. Korištene su dvije vrste ortodontskog adheziva:

1. svjetlosno polimerizirajući smolom ojačani GIC Fuji Ortho LC (GC Corporation, Tokijo, Japan)
2. sjetlosno polimerizirajuća kompozitna smola Transbond XT (3 MUnitek, Monrovia, Kalifornija, SAD).

S obzirom na način pripreme cakline te na vrstu ortodontskog adhezivnog materijala, zubi su bili podijeljeni u četiri jednako velike ispitne skupine (20 u svakoj):

ture lines after extraction. Following extraction, the residue on the teeth was removed and washed away with tap water. The buccal surface was cleaned with rotating synthetic brush on slow hand piece and pumice. The teeth were disinfected in 0.1% (weight/volume) thymol solution for 24 hours. All samples were transferred to distilled water for a maximum of 4 months before testing, while the distilled water was changed every week. A written consent was obtained from the teeth donors. Two orthodontic adhesives were used:

1. Light cure resin-reinforced GIC, Fuji Ortho LC (GC Corporation, Tokyo, Japan)
2. Light cure adhesive composite resin paste, Transbond XT (3M Unitek, Monrovia, California, USA).

With regard to the enamel pretreatment and type of orthodontic adhesive, the teeth were divided into four equal examination groups (20 teeth each):

	Priprema cakline • Enamel pretreatment	Ortodontski adheziv • Orthodontic adhesive
Skupina A • Group A	10 % poliakrilna kiselina, 20 sek. • 10% polyacrylic acid, 20 sec.	Fuji Ortho LC
Skupina B • Group B	37 % ortofosforna kiselina, 15 sek. • 37% phosphoric acid, 15 sec.	Fuji Ortho LC
Skupina C • Group C	samojetkajući primer , Transbond Plus SEP, 3 sek. • self-etching primer- Transbond Plus SEP, 3 sec.	Transbond XT
Skupina D • Group D	37 % ortofosforna kiselina, 15 sek. • 37% phosphoric acid, 15sec.; primer-Transbond MIP	primer Transbond MIP; Transbond XT

Koristili smo se metalnim bravicama tipa Discovery (Dentaurum, Njemačka). Svaka caklinska površina bila je pripremljena prema navedenim protokolima i uputama proizvođača. Za osvjetljenje korištena je LED Bluephase polimerizacijska svjetiljka (Ivoclar Vivadent, Schaan, Lihtenštajn). Nakon vezivanja bravica i polimerizacije adhezivnog materijala svi su zubi 24 sata bili pohranjeni u fiziološkoj otopini na temperaturi od 37° C. Nakon toga uloženi su u gipsane kalupe te se pristupilo ispitivanju:

snaga vezivanja svakog uzorka mjerena je na digitalnoj kidalici (Zwick br:112627, Ulm, Njemačka). Za izračunavanje SBS-a pretvorene su vrijednosti snage vezivanja (N) u SBS (MPa), uzimajući u obzir površinu baze bravice od 10,3 mm^2 (dobivena od proizvođača – Dentauruma iz Njemačke).

Drugo ispitivanje obavljeno je svjetlosnom mikroskopijom (Richter Optica U2B Binocular LabMicroscope, Kina). Za procjenu preostalog materijala na površini cakline određivao se ARI (15), a bio je stupnjevan od 0 do 3 na sljedeći način:

0 = nema adheziva na caklini;
1 = manje od 50 % adheziva na caklini;
2 = više od 50 % adheziva na caklini;
3 = 100 % adheziva na caklini.

Statistička analiza obavljena je statističkim programskim paketom SPSS 17.0 Windows. Od deskriptivnih statističkih parametara izračunate su aritmetičke sredine, standardne devijacije, medijan i interkvartilne frekvencije. Za testiranje razlike među parametrijskim varijablama koristili smo se jednosmjernom analizom varijance – ANOVA-om. Nakon ANOVA-e za multiplu usporedbu između individualnih skupina korišten je Scheffeov test. Za određivanje ARI-ja

Metallic brackets Discovery for premolars were used (Dentaurum, Germany). All enamel surfaces were prepared according to the above mentioned protocols and manufacturer's instructions. LED polymerization lamp Bluephase (Ivoclar Vivadent, Schaan, Liechtenstein) was used for light curing. After brackets bonding and adhesive material polymerization, all teeth were stored for 24 hours in saline at 37^{0}C. Subsequently they were inserted into plaster molds and examination started as follows: the debonding force values for every specimen were recorded in a digital shredding machine (Zwick nr: 112627, Ulm, Germany). To calculate SBS, the debonding force values (N) were converted to SBS (MPa) by taking into account the surface area of the bracket base, which was 10.3 mm^2 (obtained from the manufacturer-Dentaurum, Germany).

The second test was performed by light microscopy (Richter Optica U2B Binocular Lab Microscope, China). The Adhesive Remnant Index (ARI) was determined (15). The ARI was ranked from 0 to 3 as follows:

0 = no adhesive on the enamel;
1 = less than 50% adhesive on the enamel;
2 = more than 50% adhesive on the enamel;
3 = 100% adhesive on the enamel.

Statistical analysis was carried out with SPSS 17.0 for Windows statistical software package. Among descriptive statistical parameters, the arithmetic means, standard deviations and median and interquartile range were calculated. For testing the difference between parametric variables, one-way analysis of variance (ANOVA) was used. Afterwards, the ANOVA Scheffe's test was used for multiple comparisons between individual groups. Chi- square test was used to ana-

upotrijebljen je Hi-kvadrat test. Razdioba podataka testirala se Kolmogorov-Smirnovljevim testom. Razlika vjerojatnosti u svim testovima od $p < 0,05$ uzeta je kao statistički značajna.

Rezultati

Rezultati testa ANOVA-e prikazani su u tablici 1. te je nađena statistički značajna razlika između skupina ($p = 0,007$).

Nakon što je na temelju ANOVA-e nađena razlika između skupina, za multiplu usporedbu između pojedinih skupina korišten je Scheffeov post-hoc test. Na temelju Scheffeova testa nađen je značajno manji SBS u skupini B u odnosu prema skupinama C ($p = 0,031$) i D ($p = 0,026$). Nije bilo statistički značajnih razlika između skupina A i B ($p = 0,091$), skupina A i C ($p = 0,975$), te skupina A i D ($p = 0,961$). Također nije bilo statistički značajnih razlika između skupina C i D ($p = 1$). Za analizu ARI-ja korišten je Hi-kvadrat test. Razlike ARI-ja prikazane su u tablici 2. Rezultati su bili slični u svim ispitivanim skupinama i nije bilo moguće utvrditi statistički značajnu razliku između svih četiriju eksperimentalnih skupina.

lyze the ARI data. The data distribution was tested by Kolmogorov-Smirnov test. Statistical difference in all tests of $p < 0.05$ was considered statistically significant.

Results

The results of ANOVA test are presented in Table 1 and a statistically significant difference between the groups was found ($p=0.007$).

After the difference between the groups was established based on ANOVA, Scheffe's post-hoc test was used for multiple comparisons between individual groups. According to Scheffe's test, a significantly lower SBS of the group B was found in relation to the group C ($p=0.031$). Also, a significantly lower SBS of the group B was found in relation to the group D ($p=0.026$). There were no statistically significant differences between group A and group B ($p= 0.091$), between group A and group C ($p=0.975$) and between group A and group D ($p=0.961$). Also, there were no statistically significant differences between group C and group D ($p=1$). Chi- square test was used to analyze the ARI data. The difference of ARI scores is presented in Table 2. Results of ARI were almost similar in all testing groups and it was not possible to determine any statistically significant difference of the ARI between all four experimental groups.

Tablica 1. Razlike u smičnoj snazi vezivanja među ispitivanim skupinama (ANOVA)
Table 1 Shear bond strength differences between examined groups (ANOVA)

	Skupina • Group									
	A		B		C		D		F	p
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD		
Smična snaga vezivanja (MPa) • Shear bond strength (MPa)	10.84	6.00	7.25	3.14	11.49	4.00	11.60	3.93	4.387	0.007

Tablica 2. Distribucija frekvencije i postotaka ARI-a (Hi-kvadrat test)
Table 2 Distribution frequency and percentages of ARI (Chi- square test)

ARI skor • ARI score	Skupina • Group								χ^2	P
	A		B		C		D			
	N	%	N	%	N	%	N	%		
0	4	20.0	4	20.0	7	35.0	10	50.0	14.026	0.094*
1	10	50.0	6	30.0	11	55.0	6	30.0		
2	1	5.0	5	25.0	0	0.0	1	5.0		
3	5	25.0	5	25.0	2	10.0	3	15.0		

Rasprava

SBS ortodontskog sustava *bravica – adheziv – caklina* ovisi o nizu različitih čimbenika, kao što su vrsta adheziva, oblik baze bravice, morfologija cakline, način primjene i kliničke metode rada (16). Teži se usavršavanju i optimiziranju metoda vezivanja bravica za caklinsku površinu (17). U ovom istraživanja analiziran je SBS ortodontskih metalnih bravica ovisno o primijenjenom predtretmanu cakline i o vrsti korištenog adheziva (smolom ojačani GIC ili kompozitna smola). Također se želio ustanoviti utjecaj različitih adheziva i predtretmana cakline na ARI-ju. Stoga možemo reći da su ciljevi ovog istraživanja bili usmjereni na rasvjetljavanje či-

Discussion

SBS of bracket - adhesive - enamel system in orthodontic bonding varies and depends on factors such as the adhesive types, design of the bracket base, morphology of the enamel, appliance force systems and the clinician's technique (16). The orthodontic profession is constantly searching improvements and optimization of the technique of bonding brackets to enamel (17). In this study, SBS of metallic orthodontic brackets was analyzed regarding to applied enamel pretreatment and the type of used adhesive material (resin-reinforced GIC or composite resin). The aim was also to determine the influence of various adhesive materials and enamel

njenica u kojoj mjeri metode pripreme cakline utječu na SBS te koliko SBS ovisi o primijenjenom adhezivnom materijalu. Nakon statističke analize dobivenih podataka, pronašli smo statistički značajno manji SBS u skupini B u odnosu na skupine C (p = 0,031) i D (p = 0,026).

Rezultati dosadašnjih istraživanja bili su nejednaki. Tako su rezultati Shinyja i suradnika pokazali da na SBS ne utječe značajno ni jetkanje caklinske površine ni vrsta adhezivnog materijala (18). Naši rezultati pokazali su, pak, da vrsta adhezivnog materijala značajno utječe na SBS. Scougall Vilchis i njegovi suradnici pokazali su da je SBS statistički manji nakon jetkanja cakline SEP-om u odnosu na jetkanje 37-postotnom ortofosfornom kiselinom (19). Njihov zaključak nije bio u skladu s našim rezultatima. Naši rezultati bili su u korelaciji s izvješćem Cal-Neta i njegovih kolega koji nisu pronašli značajnu razliku u SBS-u između Transbond MIP-a i Transbond SEP-a (20). Scribante i suradnici komparirali su SBS Transbond XT, Fuji Ortho LC i adhezivni sustav Tetric Flow te zaključili da je SBS najjači pri korištenju adhezivnog sustava Transbond XT (21). Naši rezultati slažu se s tim izvješćem. Yassaei i suradnici komparirali su SBS Transbond XT i Fuji Ortho LC za vezivanje metalnih i keramičkih bravica te zaključili da je SBS uz Transbond XT statistički bolji u odnosu prema Fuji Orthou LC (22). Mi smo se koristili samo metalnim bravicama i naši rezultati pokazali su isto. Nulta hipoteza je prihvaćena i podupiru je dobiveni rezultati. U našem istraživanju većina rezultata za ARI u svim ispitivanim skupinama bila je 0 ili 1, što upućuje na činjenicu da će adheziv nakon skidanja bravica vjerojatnije ostati na bravici negoli na caklini. Iz kliničke perspektive to je poželjno jer zahtijeva kraće vrijeme za čišćenje cakline te je pacijentu postupak manje neugodan. Što je manji ostatak adheziva na površini zuba, to je manja mogućnost da će se pri skidanju bravica oštetiti caklinska površina (23).U našem istraživanju nije pronađena značajnija razlika za ARI između skupina, te se varijacije indeksa ARI-ja mogu pripisati slučaju, što je u skladu s ishodima ranijih istraživanja Rixa i suradnika te Movahheda i njegovih kolega (24, 25). Rezultati ARI-ja korišteni su za definiranje neuspjeha vezivanja sustava *caklina – adheziv – bravica*. U našem istraživanju na neuspjeh vezivanja nisu utjecale ni vrste adhezivnog materijala, ni metode pripreme cakline.

Zaključak

Kompozitna smola pokazuje veći SBS nego GIC. Možemo zaključiti da je uporaba kompozitnih smola, uz odgovarajuću pripremu cakline prema uputama proizvođača, *zlatni standard* u vezivanju bravica u fiksnoj ortodonciji.

Sukob Interesa

Nije bilo sukoba interesa.

pretreatment on the ARI. Therefore, it can be said that the aims of the present study were directed toward clarification of the facts to what extent enamel pretreatment methods influenced SBS and to what extent SBS depended on the applied adhesive material. After statistical analysis of the collected data, statistically significant lower SBS of the group B was found in relation to the groups C (p=0.031) and D (p=0.026).

The results of previous studies were uneven. The results of Shinya et al. revealed that SBS was neither significantly influenced by etching pattern on the enamel surface nor by the adhesive system (18). Our results showed that SBS was significantly influenced by the adhesive system. Scougall Vilchis et al. showed that when enamel was conditioned with SEP, SBS was statistically lower than when it was etched with 37% phosphoric acid (19). Our results were not consistent with their conclusion. Our results were in agreement with the report by Cal-Neto et al. who did not find any significant difference SBS between usage of Transbond MIP and Transbond SEP (20). Scribante at al. compared SBS with Transbond XT, Fuji Ortho LC and Tetric Flow adhesive systems and reported that the highest SBS was found with Transbond XT adhesive system (21). Our results were consistent with that report. Yassaei et al. compared SBS with Transbond XT and Fuji Ortho LC for bonding metal and ceramic brackets and reported that SBS when using Trans-bond XT was statistically better than with Fuji Ortho LC (22). We used metal brackets only and our results were identical. The null hypothesis was supported and confirmed by our results. Our study showed that the great amount of ARI scores in all examined groups were 0 or 1, referring to the fact that adhesives had a better chance to stay on the bracket as opposed to the enamel after debonding procedures. From the clinical perspective, that would be desirable as it would take less time for enamel clean-up and less discomfort for patients. Less adhesive remaining on the tooth surface would result in a reduction of the damage of enamel during the debonding procedures (23). No significant difference between groups according to the ARI was found in our study and the established variation of the ARI within testing groups could be declared as accidental, which is in accordance with previous study of Rix et al. and Movahhed et al. (24, 25). ARI scores are used to define the site of bond failure between the enamel, adhesive, and bracket base. In our study, bond failure site was unaffected by the type of adhesive material and methods of enamel pretreatment.

Conclusion

Composite resin showed a higher shear bonding strength than GIC. From our results it can be concluded that the use of composite resin material with appropriate enamel pretreatment according to manufactures recommendation is the "gold standard" for brackets bonding for fixed orthodontic appliances.

Conflict of interest

None declared

Abstract

Aim: The objective of present study was to examine influence of adhesives and methods of enamel pretreatment on the shear bond strength (SBS) of orthodontic brackets. The adhesives used were resin-reinforced glass ionomer cements-GIC (Fuji Ortho LC) and composite resin (Transbond XT). **Material and Methods:** The experimental sample consisted of 80 extracted human first premolars. The sample was divided into four equal groups, and the metal brackets were bonded with different enamel pretreatments by using two adhesives: group A-10% polyacrylic acid; Fuji Ortho LC, group B–37% phosphoric acid; Fuji Ortho LC, group C–self etching primer; Transbond XT, group D–37% phosphoric acid, primer; Transbond XT. SBS of brackets was measured. After debonding of brackets, the adhesive remnant index (ARI) was evaluated. **Results:** After the statistical analysis of the collected data was performed (ANOVA; Sheffe post-hoc test), the results showed that significantly lower SBS of the group B was found in relation to the groups C (p=0.031) and D (p=0.026). The results of ARI were similar in all testing groups and it was not possible to determine any statistically significant difference of the ARI (Chi- square test) between all four experimental groups. **Conclusion:** The conclusion is that the use of composite resins material with appropriate enamel pretreatment according to manufacturer's recommendation is the "gold standard" for brackets bonding for fixed orthodontic appliances.

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Address for correspondence
Professor Hrvoje Jurić, DMD, PhD
University of Zagreb
School of Dental Medicine
Department of Paedodontics and
Preventive Dental medicine
HR-10 000 Zagreb, Gundulićeva 5
Tel: + 385 1 4802 111
juric@sfzg.hr

Key words
Orthodontic Brackets; shear bond strength; Adhesives; Composite Resins; Dental Enamel

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