Effect of a universal adhesive on shear bond strengths of metal orthodontic brackets

Metal ortodontik braketlerde üniversal adezivlerin makaslama bağlanma dayanım kuvvetlerine etkisi

Assist. Prof. Aslıhan Zeynep Oz
Ondokuz Mayıs University, Faculty of Dentistry, Department of Orthodontics, Samsun
Orcid ID: 0000-0001-9168-5743

R.A. Kadir Kolcuoğlu
Ondokuz Mayıs University, Faculty of Dentistry, Department of Orthodontics, Samsun
Orcid ID: 0000-0001-6787-793X

Assist. Prof. Abdullah Alper Oz
Ondokuz Mayıs University, Faculty of Dentistry, Department of Orthodontics, Samsun
Orcid ID: 0000-0003-1976-9581

Assoc. Prof. Emel Karaman
Ondokuz Mayıs University, Faculty of Dentistry, Department of Orthodontics, Samsun
Orcid ID: 0000-0002-8922-761X

Received: 15 June 2017

Accepted: 17 January 2018

doi: 10.5505/yeditepe.2019.57966

Corresponding author:
Assist. Prof. Aslıhan Zeynep Oz
Ondokuz Mayıs University, Faculty of Dentistry, Department of Orthodontics, Samsun
Phone: 0362 312 1919-8188, 05057038107

SUMMARY

Aim: Due to the development in operative dentistry, some new bonding systems have been presented. The aim of this study was to investigate the effects of the use of a last generation universal adhesive on in vitro shear bond strengths and compare with controls.

Material and methods: This study was conducted with 68-extracted human premolar. The samples divided in to four groups. In-group 1, enamel surfaces were etched and brackets were bonded with Transbond XT adhesive primer (3M Unitek, Monrovia, Calif). In-group 2, one-step self-etching primer (Transbond plus self-etching primer, 3M Unitek, Monrovia, CA, USA) was used. In group 3 teeth were etched 37% phosphoric acid for 10 seconds and brackets were bonded with universal adhesive (Clearfil Universal Bond, Kuraray, Noritake Dental Inc.) In-group 4, universal adhesive was used on self-etching mode. The same adhesive paste (Transbond XT, 3M Unitek, Monrovia, Calif) and light-curing times were used in all groups. Shear bond strengths of the samples were compared with analysis of variance (ANOVA). The amount of residual adhesive index (ARI) was also evaluated.

Results: The mean shear bond strength values of 4 groups were 13.42±5.09 Mpa, 11.57±3.12 Mpa, 11.15±3.08, Mpa, 11,38±3.04 Mpa, respectively. There was no significant difference between the shear bond strengths of the groups. There was also no significant difference between the ARI scores.

Conclusion: Universal adhesives can be used safely for orthodontic bracket bonding with etch or self-etching mode.

Keywords: Orthodontic treatment, Universal bond, Shear bond Strength.

ÖZET

Amaç: Operatif diş hekimliğindeki gelişmeler ile birlikte bazı yeni bonding sistemleri tanıtılmıştır. Bu çalışmanın amacı son jenerasyon üniversal adezivlerin makaslama kuvvetlerine etkisinin araştırılması ve kontrol grubuyla karşılaştırılmasıdır.

Gereç ve Yöntem: Çalışmada 68 adet çekilmiş insan premolar dişi kullanıldı. Örnekler dört gruba ayrıldı. 1. grupta, mine yüzeyleri asitlendi ve braketler Transbond XT (3M Unitek, Monrovia, Calif) adeziv primer ile yapıştırıldı. 2. grupta, tek basamaklı self-etch primer (Transbond plus self-etching primer, 3M Unitek, Monrovia, CA, USA) kullanıldı. 3. grupta dişler %37 lik fosforik asitle 10 saniye asitlendi ve braketler üniversal adeziv ile (Clearfil Universal Bond, Kuraray, Noritake Dental Inc.) yapıştırıldı. 4. grupta, universal adeziv self-etch modunda kullanıldı. Örneklerin makaslama bağlanma dayanım kuvvetleri varyans analiziyle (ANOVA) karşılaştırıldı. Ayrıca artık adeziv indeksi (AAİ) de değerlendirildi.

Bulgular: Grupların ortalama makaslama kuvveti değerleri sırasıyla, 13,42±5,09 Mpa, 11,57±3,12 Mpa, 11,15±3,08, Mpa, 11,38±3,04 Mpa'dır. Gruplar arasında makaslama kuvvetleri ve AAİ skorları açısından anlamlı farklılık yoktu.

Sonuç: Üniversal adezivler ortodontik braketlerin yapıştırılma-

sında asitle veya self-etch moduyla güvenle kullanılabilir.
Anahtar kelimeler: Ortodontik tedavi, Makaslama Bağlanma Dayanım kuvveti, Universal bond.

INTRODUCTION

Conventional orthodontic bonding procedure consists of three steps: 1) Enamel preparation 2) Primer solution 3) Adhesive resin. It is essential to remove the pellicle for achieving optimal bond strength during enamel preparation. For this purpose acid etching with ortophosphoric acid are recommended.[1] But in orthodontic patients, it is not practical to bond more than a few teeth with this technique. Recently, self-etch primers become available. These primers combine the first two steps of bonding procedure and provide less chair time to orthodontist and indirectly to the patients. It also prevents enamel surface from loosening excessive enamel layer and constitutes less demineralization.[2]

The shear bond strengths values of self-etching primers range from 2.8 to 11.55 MPa.[3] Some studies reported that self-etch primers had higher values of shear bond strength than conventional systems.[4,5] On the other hand, other studies concluded that bond strengths of self-etching primers were significantly less than that of conventional bonding.[6,7] Also it was reported that when using the acid etching before bonding with self-etch primer greater bond strengths was obtained.[8-10] Although different results have presented in literature, these values is enough for orthodontic bonding.[11]

Clearfil Universal bond is the last generation new adhesive that contains 10-Methacryloyloxydecyl dihidrogen phosphate (MDP). This monomer gives the chance to use them either enamel or metal and ceramic surfaces. Several studies have been made to evaluate the performance of universal adhesive in restorative dentistry[12] but there is no information about bonding performance of these materials to the orthodontic bracket.

The aim of this study was to investigate the effects of the use of a last generation universal adhesive on in vitro shear bond strengths and compare with controls.

MATERIAL AND METHODS

This study was approved by the regional ethics committee (OMUKAEK 2017/433). The study was conducted with 68-extracted human premolar. Teeth were cleared and stored in distilled water. The sample size of the study was determined using a past study[13] and 16 teeth for per group gave %95 power based on a significance level of 0.05. The samples divided in to four groups. In group 1, enamel surfaces were etched with 37% ortophosphoric acid for 10 seconds; than the teeth were rinsed and dried with oil-free air. Transbond XT adhesive primer (3M Unitek, Monrovia, Calif) was applied on the tooth surface. In group 2, one-step self-etching primer (Transbond plus self-etching primer, 3M Unitek, Monrovia, CA, USA) was applied to the tooth surface. In group 3 (CF), teeth were etched 37% phosphoric acid for 10 seconds and brackets were bonded with universal adhesive (Clearfil Universal Bond, Kuraray, Noritake Dental Inc.) In group 4, universal adhesive was used on self-etching mode. The same adhesive paste (Transbond XT, 3M Unitek, Monrovia, Calif) and light-curing times (20 s) were used in all groups. Shear bond strengths of the samples were measured with instron testing machine (Lloyd Instrument Plc, Fareham Hampshire, UK) with a crosshead speed of 1mm/min. The amount of residual adhesive index (ARI) was also evaluated. 0 = No adhesive on tooth surface; 1 = Less than half; 2 = More than half; 3 = All adhesive on tooth surface.

Statistical analysis

All statistical analyses were performed using a software package (SPSS version 23, Chicago, MI, USA). Descriptive statistics of shear bond strengths were calculated for each group. Shapiro–Wilk normality tests were conducted for quantitative data. Shear bond strengths of the groups were compared using analysis of variance (ANOVA). The amounts of residual adhesive index (ARI) scores of the groups were also evaluated with chi-square test. The level of significance was set at $p<0.05$.

RESULTS

The mean shear bond strength values of 4 groups were 13.42±5.09 Mpa, 11.15±3.08, Mpa, 11.57±3.12 Mpa, 11,38±3.04 Mpa, respectively. There was no significant difference between the shear bond strengths of the groups (Table 1).

Table 1. Descriptive and comparison statistics of shear bond strenghts.

	Mean (Mpa)	Standart deviation
Group 1	13.42[a]	5.09
Group 2	11.57[a]	3.12
Group 3	11.15[a]	3.08
Group 4	11.38[a]	3.04

p=0.268

There was also no significant difference between the ARI scores (Table 2).

Table2.The frequency distribution of adhesive remnant index scores and statistical comparisons.

	Sörse			
	0	1	2	3
Grup 1	2	6	8	1
Grup 2	0	3	9	5
Grup 3	0	1	8	8
Grup 4	0	4	6	7

DISCUSSION

Acid etching followed by primer is a conventional procedure for orthodontic bonding. However, it is important to provide clinically acceptable bond strength with a minimum time and enamel loss. In this manner, self-etch primers provide to decrease the chair time by combining the etchant and primer in a single step.

Transbond XT adhesive system is one of the most used

adhesive systems and is accepted as standard control group in many studies.[14-16] In the present study, Transbond XT adhesive system showed similar mean shear bond strength with other published studies.[15,17] On the other hand, results of the studies related with self-etch primers are contradictory. Romano et al.[18] found lower SBS values for self-etch primers than conventional etching. Bishara et al.[19] reported that less but clinically acceptable shear bond strengths values while using self etch primers. The results of the study are in agreement with other studies, which reported that there is no difference in shear bond strengths values between conventional acid etching and self etch primers.[6,20-22] Ideally, bond strengths between 8 and 9 MPa are required to withstand orthodontic forces.[23] In our study mean shear bond strengths were approximately 11 MPa. It means that all primers used in this study provide adequate shear bond strength for orthodontic practice.

The loosening of surface enamel and subsequent constitution of decalcification occurs after the applying strong phosphoric acid or prolonged etching.[24] Although there is no statistically significant difference between conventional and self-etch primers in our study, mean SBS value of the conventional etching group was greater than the other groups. So, the using self-etching primers may be advantageous because of inhibiting the decalcification effect of the phosphoric acid on enamel surfaces by skip this stage.[20,25,26]

Universal adhesive systems are mostly investigated for restorative or prosthetic purposes. There is no information about the performance of Clearfil Universal Bond in orthodontic bonding. Hellak et al.[15] investigated the shear bond strength performance of another last generation universal bond during orthodontic bonding and compared with Transbond XT. ScotchbondTM Universal adhesive system revealed similar bonding values with conventional group. These results were supports our findings.

According to manufacturer's instructions Clearfil Universal Bond can be used with total-etch or self-etch mode. Past studies found that acid etching prior to universal adhesives application increases the shear bond strengths values.[27,28] Contrary to these studies, our results indicated that there is no statistically significant difference between self-etch or etch-and-rinse method of the universal bond. Clearfil Universal bond provided similar results regardless of which mode is applied. Also, this primer may be alternative to other primers due to containing MDP especially in patients with metal and ceramic restorations. But this was an in-vitro study and results may differ from results found in the in-vivo design. Further studies are needed to evaluate the clinic performance of these primers.

CONCLUSION

Results of the study suggest that Clearfil universal bond can be safely used with self-etch mode for orthodontic bonding.

REFERENCES

1.Ishioka S, Caputo AA. Interaction between the dentinal smear layer and composite bond strength. J Prosthet Dent 1989; 61(2): 180-185.

2.Cal-Neto JP, Miguel JA. Scanning electron microscopy evaluation of the bonding mechanism of a self-etching primer on enamel. Angle Orthod 2006; 76(1): 132-136.

3.Trites B, Foley TF, Banting D. Bond strength comparison of 2 self-etching primers over a 3-month storage period. Am J Orthod Dentofacial Orthop Dec 2004; 126(6): 709-716.

4.Bishara SE, Oonsombat C, Soliman MM, Warren JJ, et al. Comparison of bonding time and shear bond strength between a conventional and a new integrated bonding system. Angle Orthod 2005; 75(2): 237-242.

5.Buyukyilmaz T, Usumez S, Karaman AI. Effect of self-etching primers on bond strength--are they reliable? Angle Orthod 2003; 73(1): 64-70.

6.Bishara SE, VonWald L, Laffoon JF, Warren JJ. Effect of a self-etch primer/adhesive on the shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 2001; 119(6): 621-624.

7.Yamada R, Hayakawa T, Kasai K. Effect of using self-etching primer for bonding orthodontic brackets. Angle Orthod 2002; 72(6): 558-564.

8.Erhardt MC, Cavalcante LM, Pimenta LA. Influence of phosphoric acid pretreatment on self-etching bond strengths. J Esthet Restor Dent 2004; 16(1): 33-40; discussion 41.

9.Luhrs AK, Guhr S, Schilke R, Borchers L, et al. Shear bond strength of self-etch adhesives to enamel with additional phosphoric acid etching. Oper Dent 2008; 33(2):155-162.

10. Hamdani S, Anita G, Sodawala J, Gandhi S, Ali SM. The effect of pre-etching with 37% orthophosphoric acid on the shear bond strength of orthodontic brackets bonded using self-etching primer-adhesive system. Indian J Dent Res 2016; 27(5): 498-501.

11. Reynolds I. A review of direct orthodontic bonding. Br J Orthodont 1975; 2: 171-178.

12. Perdigão J, Kose C, Mena-Serrano AP, De Paula EA, et al. A new universal simplified adhesive: 18-month clinical evaluation. Oper Dent 2014; 39(2): 113-127.

13. Akdeniz BS, Oz AZ,Arıcı N, Demir O, Arıcı S. Using Hemostatic Agents During Orthodontic Bonding: An In Vitro Study. Turkish J Orthod 2015; 28: 38– 43.

14. Iijima M, Ito S, Yuasa T, Muguruma T, et al. Bond strength comparison and scanning electron microscopic evaluation of three orthodontic bonding systems. Dent Mater

J 2008; 27(3): 392-399.
15. Hellak A, Ebeling J, Schauseil M, Stein S, et al. Shear Bond Strength of Three Orthodontic Bonding Systems on Enamel and Restorative Materials. Biomed Res Int 2016; 2016: 6307107.
16. Amm EW, Hardan LS, BouSerhal JP, Glasl B, Ludwig B. Shear bond strength of orthodontic brackets bonded with self-etching primer to intact and pre-conditioned human enamel. J Orofac Orthop 2008; 69(5): 383-392.
17. Sharma S, Tandon P, Nagar A, Singh GP, et al. A comparison of shear bond strength of orthodontic brackets bonded with four different orthodontic adhesives. J Orthod Sci 2014; 3(2): 29-33.
18. Romano FL, Tavares SW, Nouer DF, Consani S, Borges de Araujo Magnani MB. Shear bond strength of metallic orthodontic brackets bonded to enamel prepared with Self-Etching Primer. Angle Orthod 2005; 75(5): 849-853.
19. Bishara SE, Oonsombat C, Ajlouni R, Laffoon JF. Comparison of the shear bond strength of 2 self-etch primer/adhesive systems. Am J Orthod Dentofacial Orthop 2004; 125(3): 348-350.
20. Cal-Neto JP, Carvalho F, Almeida RC, Miguel JA. Evaluation of a new self-etching primer on bracket bond strength in vitro. Angle Orthod 2006; 76(3): 466-469.
21. Larmour CJ, Stirrups DR. An ex vivo assessment of a bonding technique using a self-etching primer. J Orthod 2003; 30(3): 225-228.
22. Arnold RW, Combe EC, Warford JH, Jr. Bonding of stainless steel brackets to enamel with a new self-etching primer. Am J Orthod Dentofacial Orthop 2002; 122(3): 274-276.
23. Sunna S, Rock WP. Clinical performance of orthodontic brackets and adhesive systems: a randomized clinical trial. Br J Orthod 1998; 25(4): 283-287.
24. Kim MJ, Lim BS, Chang WG, Lee YK, et al. Phosphoric acid incorporated with acidulated phosphate fluoride gel etchant effects on bracket bonding. Angle Orthod 2005; 75(4): 678-684.
25. Cehreli ZC, Altay N. Effects of a nonrinse conditioner and 17% ethylenediaminetetraacetic acid on the etch pattern of intact human permanent enamel. Angle Orthod 2000; 70(1): 22-27.
26. Dorminey JC, Dunn WJ, Taloumis LJ. Shear bond strength of orthodontic brackets bonded with a modified 1-step etchant-and-primer technique. Am J Orthod Dentofacial Orthop 2003; 124(4): 410-413.
27. Diniz AC, Bandeca MC, Pinheiro LM, et al. Influence of Different Etching Modes on Bond Strength to Enamel using Universal Adhesive Systems. J Contemp Dent Pract 2016; 17(10): 820-825.
28. Suzuki T, Takamizawa T, Barkmeier WW, Tsujimoto A, et al. Influence of Etching Mode on Enamel Bond Durability of Universal Adhesive Systems. Oper Dent 2016; 41(5): 520-530.