Shear Bond Strength of Orthodontic Brackets after Accelerated Artificial Aging

Brahim Drubi-Filho, Ana Beatriz Silva Sousa, Michelle Alexandra Chinelatti and Fernanda Carvalho Panzeri Pires-de-Souza*

Ribeirão Preto School of Dentistry, University of São Paulo, Av. do Café, s/n - Monte Alegre 14040-904 - Ribeirão Preto – SP, Brazil

Abstract: The purpose of this study was to compare the shear bond strength (SBS) and the adhesive remnant index (ARI) after Accelerated Artificial Aging (AAA) of metal orthodontic brackets bonded with self-polymerizing (Concise Ortodôntico - CS, 3M Unitek) and light activated (Transbond Plus Color Change - TPCC, 3M Unitek) composites to enamel after different surface treatments. Methodology: 60 human premolars were separated into 5 groups (n=12): Group I - 37% phosphoric acid (PA Dental Gel, Dentsply) and CS; Group II – PA + Primer and CS; Group III - PA and TPCC; Group IV - PA + XT Primer (3M Unitek) and TPCC; and Group V – Transbond Plus Self Etching Primer - SEP (3M Unitek) and TPCC. Twenty-four hours after bracket bonding, half of the specimens from each group were submitted to AAA for 960 hours. The samples were submitted to the shear bond strength (SBS) test in a universal test machine (0.5mm/min). ARI was evaluated under a loupe (10X) and quantified using a score (0-3). Data were submitted to 2-way ANOVA and Bonferroni's test (α=5%). Results: Group II without AAA showed the highest mean value of SBS ($p<0.05$) in comparison with Groups III and V, which showed the lowest mean of SBS, when comparing the adhesive systems used. All groups without AAA presented a greater frequency of score 3, regarding the ARI. There was an increase in the frequency of scores 1 and 2 when specimens were submitted to AAA, Conclusion: AAA did not influence the SBS of brackets, but reduced the area of ARI.

Keywords: Adhesive Systems, Composite Degradation, Enamel, Surface Treatment, Weathering.

INTRODUCTION

Previously, fixed orthodontic appliances were placed on all the patients teeth, which resulted in work intensive procedures, a great deal of time spent on clinical consultations, discomfort to the patient, unfavorable esthetics, and interdental spaces remaining after the appliance was removed [1].

After 1965, with the use of enamel acid etching before the restorative material [2], the bands were replaced by orthodontic accessories fixed directly onto enamel by means an adhesive material [3-5]. The cost reduction this technique provided, allied to the development of new bracket base designs, made it easier for professionals to apply orthodontic mechanics, and for patients who were apt to undergo orthodontic treatment to have greater access to this treatment [6].

Direct bonding of the accessory to the tooth allows greater biofilm control, greater control of gingival inflammation, less enamel decalcification, and better esthetics. In addition, this technique allows caries lesions to be detected more easily, eliminating tooth separation and diminishing the time of clinical attendance [1, 7-8].

Nowadays, composites are the materials most used for bonding orthodontic accessories to the teeth [6, 9]. They may be self-polymerizing, or light-activated, and in order to allow and adequate bond of the accessory to the tooth, they require surface treatment so that bond failures do not occur.

It is known that accelerated artificial aging (AAA) is an agent causing the degradation of composites [10-13]. However, in the literature there are no reports of studies that have analyzed the strength of the bracket/tooth bond after aging, to verify its longevity and integrity throughout orthodontic treatment. This knowledge is important to enable better correlation of *in vitro* with *in vivo* situations present in the oral cavity, in spite of knowing the limitations of any *in vitro* study.

Thus, the aim of this study was to evaluate *in vitro* the shear bond strength (SBS) and the adhesive remaining index (ARI) after AAA of metal orthodontic brackets bonded with self-polymerizing and light-activated composites with different enamel surface treatments. The null hypothesis tested was that there is no difference in the shear bond strength, regardless of the type of composite used and surface treatment studied.

MATERIALS AND METHODS

1. Teeth Selection

Sixty recently extracted healthy human maxillary first premolars are selected, with approval from the

*Address correspondence to this author at the Department of Dental Materials and Prosthodontics, Ribeirão Preto School of Dentistry, University of Sao Paulo, Av. do Café, s/n - Monte Alegre 14040-904 - Ribeirão Preto – SP, Brazil; Tel: 55 16 36023973; Fax: 55 16 36024780; E-mail: ferpanzeri@usp.br

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Table 1: Groups Analyzed in the Study

Groups	Composite	Surface Treatment
1	Concise Orthodontic (3M Unitek, Monrovia, CA, USA)	37% phosphoric acid (3M Unitek, Monrovia, CA, USA)
2	Concise Orthodontic	37% phosphoric acid + primer + chemically polymerized adhesive (Concise Orthodontic)
3	Transbond Plus Color Change (3M Unitek, Monrovia, CA, USA)	37% phosphoric acid (Acid Gel, Villevie, Joinville, SC, Brazil)
4	Transbond Plus Color Change	37% phosphoric acid + XT Primer + Transbond XT, (3M Unitek, Monrovia, CA, USA)
5	Transbond Plus Color Change	Transbond Plus Self Etching Primer (3M Unitek, Monrovia, CA, USA)

Research Ethics Committee (Process No. 2010.1.1136.58.7). The teeth presented an intact enamel surface, without alteration due to chemical or mechanical agents. The teeth were cleaned, immersed in a 0.1% Thymol solution for 7 days for disinfection. After, they were washed in running water and stored in distilled water at 6^{o}C until sample preparation.

The teeth were embedded in PVC rings (20mm high x 20mm diameter), using self-polymerizing acrylic resin (Vipi Flash, Vipi, Pirassununga, SP, Brazil), so that they were centralized with the vestibular surface perpendicular to the horizontal plane. This surface was cleaned by means of prophylaxis with Pumice stone (SS White, Petrópolis, RJ, Brazil) at low speed (MRS 400, Dabi Atlante, Ribeirão Preto, SP, Brazil) using a rubber cup (Microdont Micro Usinagem, São Paulo, SP, Brazil) for every 5 teeth. After this, the teeth were randomly separated into 5 groups (n=12) according to the type of enamel surface treatment and composites used for bracket bonding (Table **1**).

2. Bracket Bonding

Sixty metal brackets were used of the Standard Edgewise Slot 22” (Morelli Ortodontia, Sorocaba, SP, Brazil) type, with a total base area of 12.9mm^2, which were bonded to the vestibular enamel surface of the teeth, according to the following groups:

Group 1

Enamel acid etching for 60 seconds, washing with water for 30 seconds, drying with jet of air, placement of composite and fixation on teeth.

Group 2

Enamel acid etching as performed in Group 1 + primer and adhesive of which the composite kit was composed. After polymerizing the adhesive system, the brackets were bonded.

Group 3

Enamel treatment same as performed in Group 1 + placement of light activated composite + Light activation (FlashLite 1401, Discus Dental - Culver City, CA, USA) for 10 seconds, in accordance with the manufacturer’s instructions.

Group 4

Enamel treatment same as performed in Group 1 + XT Primer + light activation (FlashLite 1401, Discus Dental) for 10 seconds, in accordance with the manufacturer’s instructions + bracket fixation in the same way as performed in Group 3.

Group 5

Application, for 3 seconds, of the self-etching adhesive system Transbond Plus Self Etching Primer (TPSEP), with circular movements + application of the adhesive agent + light jet of air for 2 seconds + bracket fixation in the same way as performed in Groups 3 and 4.

Bracket fixation was performed with orthodontic forceps (Morelli Ortodontia, Sorocaba, SP, Brazil) following the long axis and at 3.5mm from the vestibular cuspid (Estrela de Boone, Morelli Ortodontia, Sorocaba, SP, Brazil). The bracket was pressed onto the tooth with the aid of a Gillmore needle (450g) for 5 seconds, to standardize the force and time used. The excess composite was removed from the extremities of the bracket. After polymerizing the composites, the samples were immersed in distilled water and stored at 37°C for 24 hours.

3. Accelerated Artificial Aging (AAA)

Half of the samples of each group (n=6) were submitted to AAA for non-metal C-UV (Comexim Matérias Primas Ltda, São Paulo, SP, Brazil). This system simulates the nature forces, predicting the relative durability of materials exposed to ultraviolet light sources (UV-B), with radiation of 280/320nm as occurs in nature.

The aging program established for this study was 4 hours of exposure to UV-B at 50°C and 4 hours of condensation at 50°C, up to the total of 960 hours, which corresponds to 2 years of clinical use of the material [14].

The other half of the samples, which were not submitted to AAA, was considered their respective control groups.

4. Shear Test

The shear test was performed in a universal test machine (DL 200, EMIC, São José dos Pinhais, PR, Brazil) at a crosshead speed of 0.5mm/min. Each sample was positioned on the machine's basis and the load was applied by a chisel at the bracket/enamel interface and parallel to the long axis of the tooth (Figure **1**). The force necessary to bracket debonding was registered in kilograms.force (kgf) and converted into Megapascals (MPa).

Figure 1: Chisel extremity positioned at the bracket/enamel interface during the SBS test.

5. Statistical Analysis

The shear bond strength values (SBS) were statistically compared by 2-way ANOVA (factors: 1-AAA; 2- enamel surface treatments / composites), and Bonferroni test at a significance level of 5%, using GraphPad Prism 4.0® software.

6. Adhesive Remnant Index (ARI)

After the shear bond strength test the teeth were examined under a loupe (Lupa ICEL TL 1106, Manaus, AM, Brazil) at 10x magnification, to quantify the ARI to enamel [15]:

0: Without adhesive on the surface;

1: Less than half of the surface with adhesive;

2: Over half of the surface with adhesive;

3: The entire enamel surface with adhesive remnant, with distinct impression of the bracket mesh on the adhesive.

After data verification, the distribution of the frequency of ARI was calculated in percentage in the samples with and without AAA.

7. Fracture Patterns

The fracture patterns were classified as cohesive and adhesive. Cohesive (Figure **2**) when there was adhesive remnant on the tooth and the bracket surfaces after removing the bracket. The adhesive pattern was sub-divided into two situations: material/bracket adhesive (Figure **3**), when the

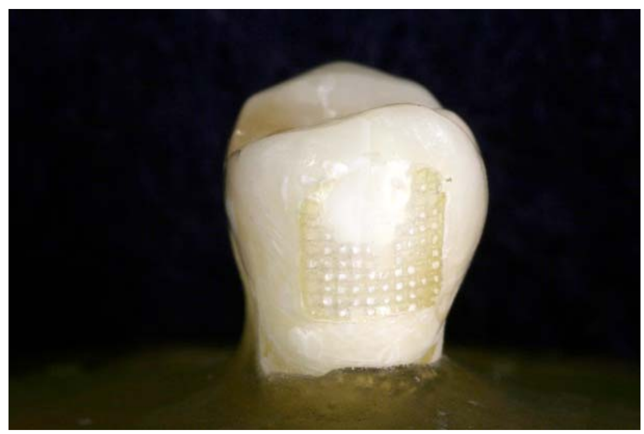

Figure 2: An example of cohesive failure pattern.

Figure 3: Adhesive failure pattern: material/bracket adhesive.

Figure 4: Adhesive failure pattern: material/tooth adhesive (the enamel surface presented no adhesive remnant; the adhesive remained adhered to the bracket).

adhesive remnant remained on the enamel surface; and material/tooth adhesive (Figure **4**), when the enamel surface presented no adhesive remnant; that is to say, the adhesive remained adhered to the bracket.

RESULTS

There was no statistically significant difference between the Groups with and without AAA (p>0.05). When comparing the adhesive systems used, Group 2 without AAA showed the highest mean of SBS, a statistically significant result (p<0.05) in comparison with Groups 3 and 5, which showed the lowest mean of SBS (Table **2**).

Table 2: Comparison of Means (MPa) (Standard Deviation) of Shear Bond Strength without and with AAA (2-way ANOVA, Bonferroni Test)

	Without AAA	With AAA
Group 1	18.33 (7.43) AB	16.25 (5.94) A
Group 2	23.37 (6.34) A	18.17 (3.08) A
Group 3	10.73 (3.84) B	10.48 (2.76) A
Group 4	15.01 (2.94) AB	16.47 (6.06) A
Group 5	9.89 (4.68) B	10.31 (5.93) A

Different letters in the column indicate statistically significant differences (p<0.05). There was no statistically significant difference between the Groups with and without AAA (p>0.05).

The frequency distribution of ARI may be seen in Table **3**. Score 3 was the most prevalent in all groups, with exception of Group 3 with AAA, which presented ARI 1 and 2 (50%). Only one sample in Group 1 (17%) presented ARI zero. This score was not found in the other groups. Without AAA, all groups presented a frequency equal to or higher than 50% in Score 3. With EAA, there was a reduction in the frequency of this score, with increase in the frequency of scores 1 and 2.

The Fracture Pattern distributions without AAA and with AAA may be seen in Figures **5** and **6**. The majority of the samples in Group 3 presented a cohesive pattern, both with and without AAA, differently from the samples in Group 4, which presented prevalence of the material/bracket adhesive pattern without AAA and enamel fracture with AAA.

The samples in Group 5, without AAA presented equal prevalence for the three types of failures. After AAA, the prevalent fracture pattern of the samples was cohesive.

DISCUSSION

The aim of this study was to evaluate the SBS and ARI after AAA of metal orthodontic brackets bonded with self-polymerizing and light-activated composites, after different surface treatments. The results indicated that AAA was not a determinant factor for the reduction in tooth/bracket bond strength, irrespective of the type of composite and surface treatment used. There was a reduction in bond strength according to the type of composite and adhesive system used. Therefore, the null hypothesis tested could be only partially accepted.

All the groups presented higher SBS than the minimum force necessary to bear the normal orthodontic force (6 to 8 MPa) [16]. This force should be sufficiently high to resist accidental bracket debonding, but also low enough to allow bracket removal at finishing the treatment, without causing damage or excessive forces on the enamel [17].

The lower pH of the self-etching adhesive systems [18, 19] in comparison with prior acid etching may have been the reason for these results. In addition, there may have been less penetration of the primer in dry conditions, because this was an *in vitro* study. As the primer is hydrophilic, differently from the other systems

Table 3: Distribution of Frequency of ARI (%) on the Samples without and with AAA

	Without AAA				With AAA			
	0	**1**	**2**	**3**	**0**	**1**	**2**	**3**
G1	17%	0%	0%	83%	0%	0%	33%	67%
G2	0%	17%	0%	83%	0%	33%	0%	67%
G3	0%	17%	33%	50%	0%	50%	50%	0%
G4	0%	0%	17%	83%	0%	33%	0%	67%
G5	0%	33%	0%	67%	0%	33%	67%	0%

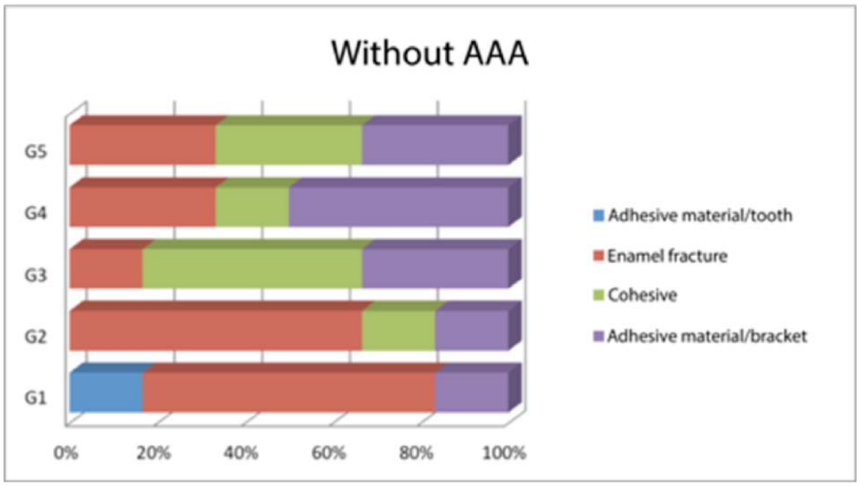

Figure 5: Percentage distribution of failure patterns for samples without AAA.

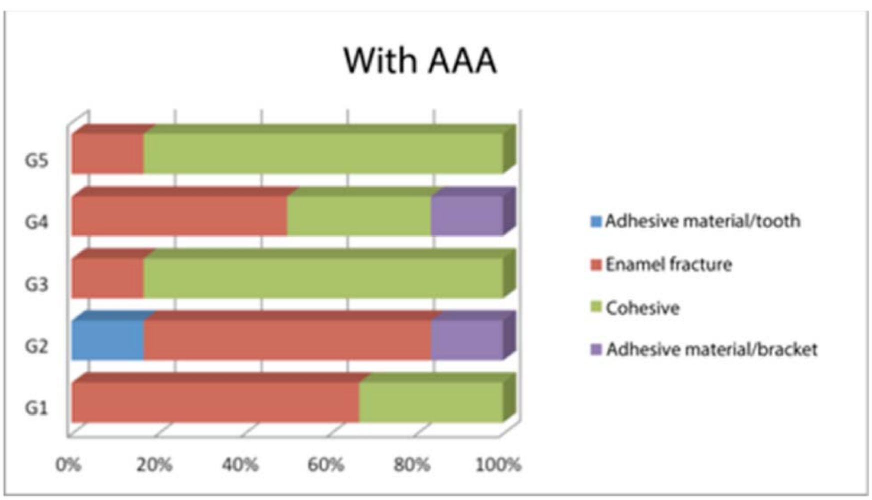

Figure 6: Percentage distribution of failure patterns for samples with AAA.

studied, there would be less penetration of the infiltrated resin, which would produce lower bond strength [20-22].

Moreover, acid etching before primer application allows good wetting and resin penetration into the enamel surface [23]. Etching allows a uniform demineralization, making the surface more receptive to the adhesive agent [24].

The hydrophilic nature of the self-etching primer may also contribute to the reduction of strength at the bond interface, due to the greater water sorption of these materials [24], resulting in a higher rate of bracket debonding [25]. The water is capable of penetrating between the polymeric chains, diminishing the binding forces of van der Waals forces, reducing the mechanical properties of the composite [26, 27]. However, as the results presented by the self-etching system are still within the desired minimum, its advantage would be the reduction in the number of clinical steps for bracket bonding [28], which would be reflected in productivity.

The ARI allowed one to visualize the type of bond strength that the tooth/bracket bond presented, whether it was adhesive or cohesive. In the case of material/bracket adhesive fracture, it could result from little penetration of the primer due to the reduced enamel demineralization [24], which could lead to less difficulty in removing the remnant material from the enamel surface [29].

The type of bracket failures depends on various factors, among them the cohesive strength of the adhesive, morphology of the bracket base, and the bond strength values achieved with the use of adhesive systems [19, 30], due to the smaller quantity of residual adhesive on the enamel surface with the self-etching adhesives used [31].

There was a high incidence of enamel fracture, and this may be justified by the high bond strength values found in all the groups, well above the accepted levels [16].

AAA was not decisive for the significant reduction in bond strength of the brackets, for any of the groups, therefore as far as aging is concerned; this allowed the null hypothesis to be accepted. In spite of the degradation that UV light causes on composites [12, 13], its action was not significant, probably due to the small amount of composite used, the high bond strength values initially achieved, and protection of the composite provided by the bracket base.

The results of this research are most relevant to the knowledge of the bracket/tooth bond with new adhesive systems on the dental market. Composites are materials that are very subject to color alteration [10], particularly when submitted to AAA [11, 32]. Therefore, the use of adhesive systems associated with these composite may allow the formation of tags that may have their color altered and make them visible after bracket debonding. Thus, further studies are suggested, which allow verification of tooth color stability after using these materials, submitted to AAA.

CONCLUSION

- AAA had no influence on the SBS of the bracket to the enamel, irrespective of the type of composite and surface treatment studied;
- Bracket bonded with self-polymerizing composite presented higher SBS than those bonded with light-activated composite, irrespective of the type of adhesive system, except when the 2-step adhesive system was used, without AAA;
- AAA led to a smaller area of ARI on the enamel surface;
- After debonding, brackets bonded to the enamel surface with the 2-step adhesive system presented a higher ARI, similar to that of the self-polymerizing composite, when compared with the brackets bonded with the light-activated composite.

REFERENCES

[1] Bryant S, Retief DH, Russell CM, Denys FR. Tensile bond strengths of orthodontic bonding resins and attachments to etched enamel. Am J Orthod Dentofacial Orthop 1987; 92(3): 225-31. http://dx.doi.org/10.1016/0889-5406(87)90416-1

[2] Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res 1955; 34(6): 849-53. http://dx.doi.org/10.1177/00220345550340060801

[3] Newman GV. Epoxy adhesives for orthodontic attachments: progress report. Am J Orthod 1965; 51(12): 901-12. http://dx.doi.org/10.1016/0002-9416(65)90203-4

[4] Ulusoy C. Comparison of finishing and polishing systems for residual resin removal after debonding. J Appl Oral Sci 2009; 17(3): 209-15. http://dx.doi.org/10.1590/S1678-77572009000300015

[5] Krishnaswamy NR, Sunitha C. Light-emitting diode vs halogen light curing of orthodontic brackets: a 15-month clinical study of bond failures. Am J Orthod Dentofacial Orthop 2007; 132(4): 518-23. http://dx.doi.org/10.1016/j.ajodo.2005.09.038

[6] Attar N, Taner TU, Tülümen E, Korkmaz Y. Shear bond strength of orthodontic brackets bonded using conventional vs one and two step self-etching/adhesive systems. Angle Orthod 2007; 77(3): 518-23. http://dx.doi.org/10.2319/0003-3219(2007)077[0518:SBSOOB]2.0.CO;2

[7] Newman GV. Adhesion and orthodontic plastic attachments. Am J Orthod 1969; 56(6): 573-88. http://dx.doi.org/10.1016/0002-9416(69)90193-6

[8] Zachrisson BU. Cause and prevention of injuries to teeth and supporting structures during orthodontic treatment. Am J Orthod 1976; 69(3): 285-300. http://dx.doi.org/10.1016/0002-9416(76)90077-4

[9] Cal-Neto JP, Miguel JA, Zanella E. Effect of a self-etching primer on shear bond strength of adhesive precoated brackets *in vivo*. Angle Orthod 2006; 76(1): 127-31.

[10] Pires-de-Souza FC, Garcia LF, Hamida HM, Casemiro LA. Color stability of composites subjected to accelerated aging

after curing using either a halogen or a light emitting diode source. Braz Dent J 2007; 18(2): 119-23. http://dx.doi.org/10.1590/S0103-64402007000200006

[11] Mundim FM, Pires-de-Souza FeC, Garcia LaF, Consani S. Colour stability, opacity and cross-link density of composites submitted to accelerated artificial aging. Eur J Prosthodont Restor Dent 2010; 18(2): 89-93.

[12] Mundim FM, Antunes PL, Sousa AB, Garcia LF, Pires-de-Souza FC. Influence of artificial accelerated ageing on the colour stability of paints used for ocular prosthesis iris painting. Gerodontology 2012; 29(2): e312-7. http://dx.doi.org/10.1111/j.1741-2358.2011.00473.x

[13] Pires-de-Souza FC, Garcia LF, Roselino LM, Naves LZ. Color stability of silorane-based composites submitted to accelerated artificial ageing--an in situ study. J Dent 2011; 39(1 Suppl): e18-24. http://dx.doi.org/10.1016/j.jdent.2011.03.003

[14] ASTM Standards G154-00A. Standard practice for operating fluorescent light apparatus for UV exposure of nonmetallic materials. In: Annual Book of ASTM Standards 2006; pp. 646-54.

[15] Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. Am J Orthod 1984; 85(4): 333-40. http://dx.doi.org/10.1016/0002-9416(84)90190-8

[16] Reynolds IR, von Fraunhofer JA. Direct bonding of orthodontic attachments to teeth: the relation of adhesive bond strength to gauze mesh size. Br J Orthod 1976; 3(2): 91-5.

[17] Ozcan M, Vallittu PK, Peltomäki T, Huysmans MC, Kalk W. Bonding polycarbonate brackets to ceramic: effects of substrate treatment on bond strength. Am J Orthod Dentofacial Orthop 2004; 126(2): 220-7. http://dx.doi.org/10.1016/j.ajodo.2003.06.015

[18] Iijima M, Ito S, Yuasa T, Muguruma T, Saito T, Mizoguchi I. Bond strength comparison and scanning electron microscopic evaluation of three orthodontic bonding systems. Dent Mater J 2008; 27(3): 392-9. http://dx.doi.org/10.4012/dmj.27.392

[19] Iijima M, Ito S, Muguruma T, Saito T, Mizoguchi I. Bracket bond strength comparison between new unfilled experimental self-etching primer adhesive and conventional filled adhesives. Angle Orthod 2010; 80(6): 1095-9. http://dx.doi.org/10.2319/012010-43.1

[20] Prati C, Chersoni S, Mongiorgi R, Pashley DH. Resin-infiltrated dentin layer formation of new bonding systems. Oper Dent 1998; 23(4): 185-94.

[21] Yap AU, Soh MS, Han TT, Siow KS. Influence of curing lights and modes on cross-link density of dental composites. Oper Dent 2004; 29(4): 410-5.

[22] Uysal T, Ustdal A, Kurt G. Evaluation of shear bond strength of metallic and ceramic brackets bonded to enamel prepared with self-etching primer. Eur J Orthod 2010; 32(2): 214-8. http://dx.doi.org/10.1093/ejo/cjp035

[23] Bishara SE, Ajlouni R, Laffoon JF, Warren JJ. Comparison of shear bond strength of two self-etch primer/adhesive systems. Angle Orthod 2006; 76(1): 123-6.

[24] Reis A, dos Santos JE, Loguercio AD, de Oliveira Bauer JR. Eighteen-month bracket survival rate: conventional versus self-etch adhesive. Eur J Orthod 2008; 30(1): 94-9. http://dx.doi.org/10.1093/ejo/cjm089

[25] Littlewood SJ, Mitchell L, Greenwood DC. A randomized controlled trial to investigate brackets bonded with a hydrophilic primer. J Orthod 2001; 28(4): 301-5. http://dx.doi.org/10.1093/ortho/28.4.301

[26] Rantala LI, Lastumäki TM, Peltomäki T, Vallittu PK. Fatigue resistance of removable orthodontic appliance reinforced with glass fibre weave. J Oral Rehabil 2003; 30(5): 501-6. http://dx.doi.org/10.1046/j.1365-2842.2003.01108.x

[27] Faltermeier A, Behr M, Rosentritt M, Reicheneder C, Müssig D. An *in vitro* comparative assessment of different enamel contaminants during bracket bonding. Eur J Orthod 2007; 29(6): 559-63. http://dx.doi.org/10.1093/ejo/cjm052

[28] 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): 348-50. http://dx.doi.org/10.1016/j.ajodo.2003.04.010

[29] Hosein I, Sherriff M, Ireland AJ. Enamel loss during bonding, debonding, and cleanup with use of a self-etching primer. Am J Orthod Dentofacial Orthop 2004; 126(6): 717-24. http://dx.doi.org/10.1016/j.ajodo.2003.10.032

[30] Diedrich P. Enamel alterations from bracket bonding and debonding: a study with the scanning electron microscope. Am J Orthod 1981; 79(5): 500-22. http://dx.doi.org/10.1016/S0002-9416(81)90462-0

[31] Abdelnaby YL, Al-Wakeel ElS. Effect of early orthodontic force on shear bond strength of orthodontic brackets bonded with different adhesive systems. Am J Orthod Dentofacial Orthop 2010; 138(2): 208-14. http://dx.doi.org/10.1016/j.ajodo.2008.09.034

[32] Zanin FR, Garcia LF, Casemiro LA, Pires-de-Souza FC. Effect ofartificial accelerated aging on color stability and surface roughness of indirect composites. Eur J Prosthodont Restor Dent 2008; 16(1): 10-4.

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