Shear bond strength of Concise and Transbond XT composites with and without bonding agent

Alexandre Maêda Neves*, Fábio Lourenço Romano**, Américo Bortolazzo Correr***

Abstract

Objectives: The aim of this study was to evaluate the shear bond strength of brackets and the adhesive remnant index (ARI) of Concise and Transbond XT composites with and without the use of a bonding agent. **Methods:** The sample consisted of 60 bovine incisors divided into four groups (n=15). All teeth were subjected to prophylaxis with pumice and enamel etching with phosphoric acid at 37%. In Groups 1 and 2 brackets were bonded with Concise composite with and without application of enamel bond resin, respectively. In Groups 3 and 4, Transbond XT was used with and without XT Primer application, respectively. In these latter groups bonding was light cured for 40 seconds. Specimen shear strength testing was performed on an Instron machine at 0.5 mm/min, and ARI was subsequently evaluated. **Results:** Shear bond strength in Group 4 was statistically higher than in Groups 1 and 2 ($p<0.05$) but not when compared to Group 3 ($p>0.05$). There were no statistically significant differences between Groups 1, 2 and 3 ($p>0.05$). ARI in Group 3 was statistically higher than in Group 2 ($p<0.05$), but not statistically different from Groups 1 and 4 ($p>0.05$). There were no statistically significant differences between Groups 1, 2 and 4 ($p>0.05$). **Conclusion:** The composites Concise and Transbond XT showed adequate bond strength with or without the use of their respective bonding agents.

Keywords: Shear strength. Dental bonding. Orthodontics.

INTRODUCTION

Initially, to perform orthodontic treatment accessories were welded to bands, which were in turn cemented to all teeth. The process required prior teeth separation. This kind of fixed orthodontic appliance jeopardized the esthetic of the patient, caused infiltrations and gum diseases. It was extremely traumatic and time consuming.[1,2] Thanks to the acid etching development,[6] orthodontics has evolved from bands to the direct bonding of brackets to tooth enamel.

How to cite this article: Neves AM, Romano FL, Correr AB. Shear bond strength of Concise and Transbond XT composites with and without bonding agent. Dental Press J Orthod. 2011 Nov-Dec;16(6):63-8.

» The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.

* Specialist in Orthodontics, Dental School, University of Alfenas, Brazil.
** MSc and PhD student of Orthodontics, Piracicaba School of Dentistry, Campinas State University, FOP/Unicamp. Professor, Specialization Program in Orthodontics, University of Alfenas, Brazil.
*** MSc and PhD student in Dental Materials, Piracicaba School of Dentistry, Campinas State University, FOP/Unicamp.

When originally proposed, direct bonding technique used epoxy resin, which had many clinical, physical and chemical limitations.[18] Over time, a wide range of composites were developed and each new launch brought with it increasingly effective features.[19]

Self-curing resins were for a long time the only option for restorative dental procedures and for bonding orthodontic accessories to enamel.[15,18] This kind of material boasts great clinical efficiency but its short handling time hinders the procedure, requiring the orthodontist to have a certain amount of skill.[14,20,23]

In the late 70s, a new kind of composite was marketed whose composition comprised a substance called camphorquinone, which when exposed to light interacts with an activating agent (tertiary amine) to form free radicals which, in turn, convert the resin monomers into polymers, thereby hardening the material. These materials were called light-curing composites.[25,27]

Several experiments involving bonding of orthodontic accessories were performed to compare self-curing and light-curing materials, especially Concise and Transbond XT (3M) composites, respectively. Most experiments found similarity between the bonding strength of these composites, making it evident that both exhibit adequate adhesion to dental enamel.[5,7,8,17,23,28]

Concise and Transbond XT, when used accordingly to the manufacturer's recommendations, require the use of their own bonding agents, i.e., enamel bond resins A and B, and XT Primer, respectively. Bonding agents moisten and penetrate the enamel, promoting composite adhesion.[21] Furthermore, they protect the tooth surface that was etched but not covered against decalcification by plaque and food debris around the bracket.[16] Some authors,[12,16] however, found no difference in bonding orthodontic attachments to enamel with or without the use of a bonding agent prior to bonding. Despite some advantages, if this step in composite bonding procedure could be avoided, patient chair time would certainly diminish, facilitating the maintenance of a dry working field and preventing bond failures by contamination or moisture.

The purpose of this study was to investigate whether the use of Concise and Transbond XT bonding agents interferes with the shear bond strength of brackets bonded with these materials, while also evaluating Adhesive Remnant Index (ARI) after debonding.

MATERIAL AND METHODS

A total of 60 bovine permanent mandibular incisors were properly cleaned, placed in a solution of 10% formaldehyde and stored in a refrigerator at 6 °C. Their roots were centrally inserted in PVC tubes containing self-curing acrylic resin (Dental-Vipi, Pirassununga, Brazil) with the buccal surface of each tooth positioned perpendicularly to the base of the die. Resin excess was removed with a Lecron spatula (SS White, Rio de Janeiro, Brazil). To verify the correct positioning of each tooth, a glass positioner at an angle of 90 degrees — fabricated exclusively for this purpose — was made to rest on the buccal surface of the tooth and on top of the die.

After the teeth had been positioned, the specimens were stored in distilled water in the refrigerator until the bonding date. Prior to bonding, all buccal surfaces were subjected to prophylaxis, non-fluoridated pumice and water for 10 seconds, then washed and dried for the same time. Phosphoric acid at 37% was applied for 15 seconds to etch the enamel of all teeth, which were then washed with an air/water spray and dried for the same time.

The specimens were randomly divided into four groups (n=15), as described in Table 1.

Morelli brackets (Sorocaba, Brazil) with a base area of 14.44 mm^2 were positioned at the center of the buccal surface, pressed against it, and all composite excess was removed. These brackets were selected because the anatomy of bovine incisors resembles that of human maxillary central incisors. In Groups 3 and 4, bonding was light-cured for 40 seconds, i.e., 10 seconds on each side (mesial, distal, incisal and gingival), using curing light XL

1500 (3M ESPE, Monrovia, USA) as close as possible to the bracket base. After bonding, the specimens were once again stored in distilled water and kept in the oven at a temperature of 37 °C for 24 hours to simulate oral temperature.

After this period, shear bond strength tests were performed on the brackets using an Instron machine (Model 44.11, Canton, USA) at a speed of 0.5 mm/min with a chisel-shaped tip. Results were obtained in Kgf, converted into N and divided by the bracket base area for conversion into MegaPascal (MPa).

After debonding, each enamel surface was evaluated in a stereomicroscope (Carl Zeiss, Göttingen, Germany) with 8x magnification and rated according to the ARI scores proposed by Artun & Bergland[3], as follows:

- 0 = No composite remaining on the enamel.
- 1 = Less than half the composite remaining on the enamel.
- 2 = More than half the composite remaining on the enamel.
- 3 = All composite remaining on the enamel.

Statistical analysis

To compare shear bond strength, Analysis of Variance (ANOVA) and Tukey's test were applied with a significance level of 5%. To compare the Adhesive Remnant Index (ARI) results the Kruskal-Wallis test was employed.

RESULTS

The mean shear bond strength values and ARI results are statistically compared in Table 2.

Shear strength in Group 4 was statistically higher than in Groups 1 and 2 ($p<0.05$) but not when compared to Group 3 ($p>0.05$). There were no significant differences between Groups 1, 2 and 3 ($p>0.05$). No statistically significant differences were found between Groups 1, 2 and 3 ($p>0.05$).

Regarding the ARI results, for Group 3 it reveled to be statistically higher than for Group 2 ($p<0.05$) but showed no statistically significant differences compared to Groups 1 and 4 ($p>0.05$). No statistically significant differences were found between Groups 1, 2 and 4 ($p> 0.05$).

TABLE 1 - Groups assessed in the experiment.

Groups	Composites	Procedures*
1	Conventional Concise	Applying enamel bond resin, placing composite on bracket base and bonding
2	Concise without enamel bond resin	Applying composite to bracket base and bonding
3	Conventional Transbond XT	Applying XT primer, placing composite on bracket base and bonding
4	Transbond XT without XT primer	Applying composite to bracket base and bonding

* Procedures were performed after prophylaxis and acid etching of enamel.

TABLE 2 - Mean shear strength values (MPa), ARI median and statistical analysis between groups.

	Shear strength (MPa)		ARI	
Groups	Mean (standard deviation)	Tukey (5%)*	Median	Kruskal-Wallis
1	14.00 (1.99)	b	28.56	ab
2	14.46 (1.17)	b	24.10	b
3	19.12 (1.27)	ab	42.23	a
4	20.46 (1.4)	a	27.10	ab

Identical letters stand for no statistically significant differences (p>0,05). * Test power: $\alpha = 0.728$.

DISCUSSION

To be employed for bracket bonding a material needs to provide adhesion to the tooth surface sufficient to withstand masticatory and orthodontic forces consistently applied. According to Reynolds[22], to be suitable, such material should deliver shear strength between 5.9 and 7.8 MPa in laboratory experiments. This study found results ranging from 14 to 20.46 MPa. These values are higher than those recommended by the referred author, indicating that the tested materials and their variations can be clinically applied.

Groups 1 (conventional Concise) and 3 (conventional Transbond XT) displayed similar bond strength values with no statistically significant differences. These results partly agree with the literature[4,10] but disagree with other authors who found Transbond XT[5,8,17,28] to have higher bond strength. Conversely, other studies have found greater bond strength with Concise.[1,7,13]

Given these results and those of other experiments, it can be concluded that both materials are suitable for orthodontic bonding, considering methodological variations between experiments. One mentioned advantage of bonding with Transbond XT is greater control of working time by orthodontists, which facilitates the proper placement of brackets on the teeth.[11] On the other hand, bonding with Concise is advantageous because its polymerization process is not affected by external factors that might get in the way of the proper reaction between Concise orthodontic paste A and paste B.[15,26]

The use of a bonding agent prior to bonding with composite has the advantage of immediate obliteration of enamel pores — caused by acid etching — that are not covered by the bracket base, thereby, preventing decalcification.[16,21] Non-use of a bonding agent, however, could simplify clinical procedures and reduce chair time.[24] In Groups 2 and 4 of this study Concise and Transbond XT were utilized without their respective bonding agents. Group 4 was statistically superior to Group 2, showing greater bond strength when Transbond XT was used without XT primer than Concise without enamel bond resin. This result can only be explained by the difference in composition between the materials, although the same was not observed when the composites were used conventionally.

When each materials was compared individually, i.e., conventional Concise vs. Concise without resin, and Transbond XT vs. Transbond XT without XT Primer, no significant differences were found, which leads to the conclusion that the absence of a bonding agent did not compromise bond strength. These findings are consistent with the work of Jassem et al,[12] Farquhar[9] and Rose et al,[24] but disagree with Menezes[14], who showed that using a bonding agent creates large tags in the enamel, which despite providing higher shear strength may involve greater risk of cohesive fractures in the enamel during the debonding procedure.

In laboratory experiments involving the bonding of accessories to enamel differences or similarities in shear bond strength values are not usually accompanied by ARI results.[20,23] This study corroborated this fact. Statistical differences found in shear bond strength tests did not match the ones found in ARI analysis (Table 2). It is important to assess ARI after the debracketing procedure to check the amount of composite that remained adhered to the enamel. Ideally, all material used in the bonding procedure should remain adhered to the tooth surface (score 3)[3]. In the Groups that took part in this experiment most of the fractures occurred at the bracket/composite interface, leaving some composite on enamel, with the prevalence of score 3. These findings are commonly seen in studies that used composites to bond orthodontic accessories.[2,14,20]

CONCLUSIONS

1. Concise and Transbond XT composites exhibited adequate bond strength with or without the use of their respective bonding agents.
2. Absence of bonding agent had no impact on bond strength of Concise or Transbond XT to enamel.
3. ARI assessment revealed that most of the fractures occurred at the bracket/composite interface with some material remaining adhered to the enamel after debonding.

REFERENCES

1. Alexander JC, Viazis AD, Nakajima H. Bond strengths and fracture modes of three orthodontic adhesives. J Clin Orthod. 1993;27(4):207-9.
2. Artun J, Zachrisson B. Improving the handling properties of a composite resin for direct bonding. Am J Orthod. 1982;81(4):269-76.
3. 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.
4. Artun J. A post-treatment evaluation of multibonded ceramic brackets in orthodontics. Eur J Orthod. 1997;19(2):219-28.
5. Bengtson NG, Bengtson AL, Carvalho DS, Rossetto SM. Estudo comparativo da força adesiva de quatro materiais para colagem de braquetes. Rev Dental Press Ortod Ortop Facial. 2003;8(3):43-7.
6. Buonocore M. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res. 1955;34(6):849-53.
7. Correr Sobrinho L, Consani S, Sinhoretti MAC, Correr GM, Consani RLX. Avaliação da resistência ao cisalhamento na colagem de bráquetes, utilizando diferentes materiais. Rev ABO Nac. 2001;9(3):157-62.
8. Dolci GS, Mazzocco KC, Loguercio AD, Osinaga PWR. Resistência de união entre bráquetes metálicos e esmalte: avaliação de diferentes materiais. Ortodon Gaúch. 2000;4(2):144-56.
9. Farquhar RB. Direct bonding comparing a polyacrylic acid and a phosphoric acid technique. Am J Orthod Dentofacial Orthop. 1986;90(3):187-94.
10. Flores AR, Sáez E G, Barceló F. Metallic bracket to enamel bonding with a photopolymerizable resin-reinforced glass ionomer. Am J Orthod Dentofacial Orthop. 1999;116(5):514-7.
11. Guan G, Asai Y, Matasa CG, Hattori T, Mitani S. Resistência da colagem em relação à interface esmalte-adesivo. Rev Dental Press Ortod Ortop Facial. 1998;3(3):93-9.
12. Jassem HA, Retief DH, Jamison HC. Tensile and shear strengths of bonded and rebounded orthodontic attachments. Am J Orthod. 1981;79(6):661-8.
13. King L, Smith RT, Wendt SL Jr, Behrents RG. Bond strengths of lingual orthodontic brackets bonded with light-cured composite resins cured by transillumination. Am J Orthod Dentofacial Orthop. 1987;91(4):312-5.
14. Menezes LFS. Influência do agente de união e da viscosidade do compósito em colagens ortodônticas [dissertação]. Rio de Janeiro (RJ): Universidade Federal do Rio de Janeiro; 1991.
15. Miura F, Nakagawa K, Masuhara E. New direct bonding system for plastic brackets. Am J Orthod. 1971;59(4):350-61.
16. Moin K, Dogon IL. Indirect bonding of orthodontic attachments. Am J Orthod. 1977;72(3):261-76.
17. Mondelli AL, Feitas MR. Estudo comparativo da resistência adesiva da interface resina/bráquete, sob esforços de cisalhamento, empregando três resinas compostas e três tipos de tratamento na base do bráquete. Rev Dental Press Ortod Ortop Facial. 2007;12(3):111-25.
18. Newman GV. Bonding plastic orthodontic attachments to tooth enamel. J New Jersey Dent Soc. 1964;35(4):346-58.
19. Pinzan CRM, Pinzan A, Francisconi PAS, Lauris JRP, Freitas MR. Estudo comparativo da resistência às forças de cisalhamento, de colagem de bráquetes ortodônticos, testando dois tempos diferentes de condicionamento ácido, com e sem homogeneização das pastas. Rev Dental Press Ortod Ortop Facial. 2001;6(6):45-9.

20. Pithon MM, Santos RL, Oliveira MV, Ruellas ACO. Estudo comparativo in vitro da resistência ao cisalhamento da colagem e do índice de remanescente resinoso entre os compósitos Concise e Fill Magic. Rev Dental Press Ortod Ortop Facial. 2006;11(4):76-80.
21. Prévost AP, Fuller JL, Peterson LC. The use of an intermediate resin in the acid-etch procedure: retentive strength, microleakage, and failure mode analysis. J Dent Res. 1982;61(2):412-8.
22. Reynolds IR. A review of direct orthodontic bonding. Br J Orthod. 1975;2(3):171-8.
23. Romano FL, Ruellas ACO. Estudo comparativo in vitro da resistência ao cisalhamento da colagem e do índice de remanescente resinoso entre os compósitos Concise e Superbond. Rev Dental Press Ortod Ortop Facial. 2003;8(1):69-75.
24. Rosa CB, Pinto RAC, Habib FAL. Colagem ortodôntica em esmalte com presença ou ausência de contaminação salivar: é necessário o uso de adesivo auto-condicionante ou de adesivo hidrofílico? Rev Dental Press Ortod Ortop Facial. 2008;13(3):34-42.
25. Tavas MA, Watts DC. Bonding of orthodontic brackets by transillumination of a light activated composite: an in vitro study. Br J Orthod. 1979;6(4):207-8.
26. Tavas MA, Watts DC. A visible light-activated direct bonding material: an in vitro comparative study. Br J Orthod. 1984;11(1):33-7.
27. Vieira S, Leichsenring A, Casagrande FA, Vianna MS, Lima MH. Adesão em Ortodontia - Parte I. J Bras Ortodon Ortop Facial. 2002;7(40):344-50.
28. Wang WN, Meng CL. A study of bond strength between light- and self-cured orthodontic resin. Am J Orthod Dentofacial Orthop. 1992;101(4):350-4.

Submitted: September 18, 2008
Revised and accepted: April 26, 2009

Contact address
Fabio Lourenço Romano
Av. Engenheiro José Herbert Faleiros, 600 – casa 78
Zip code: 14.098-780 – Ribeirão Preto/SP, Brazil
E-mail: flromano@terra.com.br