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ORIGINAL RESEARCH

Comparison between the adhesion forces of two orthodontic systems with moisture affinity in two enamel surface conditions

Comparación de fuerza de adhesión de dos sistemas ortodóncicos con afinidad a la humedad en dos condiciones de superficie del esmalte

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ABSTRACT

The purpose of this study was to compare the shear bond strength of orthodontic brackets with two systems of hydrophilic adhesives: (I) a cyanoacrylate adhesive (Smartbond, International Gestenco) and (II) a composite system (Transbond XT and Transbond™ IPM) in two enamel conditions: dry and artificial saliva contaminated. **Materials and methods:** 100 extracted premolars were stored in distilled water at 4 degrees Celsius. The teeth were cleaned, polished, and convenience distributed into 5 groups: (1) composite resin in enamel under dry conditions, (2) cyanoacrylate adhesive in dry enamel condition, (3) composite resin in enamel condition contaminated with artificial saliva before the primer, (4) composite resin enamel condition contaminated with artificial saliva after the primer, and (5) cyanoacrylate adhesive in artificial saliva contaminated enamel condition. The results showed that the adhesive system Transbond XT™ and Transbond MIP obtained the highest values of resistance to debonding in the dry enamel surface. **Conclusions:** The adhesive system Transbond XT™ and Transbond MIP I provide an adequate *in vitro* resistance to debonding in every enamel condition. The system based on cyanoacrylate adhesive Smartbond obtained proper values of resistance to debonding in dry enamel, however it obtained the lowest values in contaminated with enamel artificial saliva conditions, unsuitable for orthodontics, and even some samples were not cemented successfully *in vitro* under these conditions.

RESUMEN

El propósito de este estudio fue comparar la resistencia al cizallamiento de brackets ortodóncicos de dos sistemas adhesivos hidrofílicos, éstos son: (I) adhesivo a base de cianoacrilato (Smartbond, Gestenco Internacional) y (II) una resina compuesta (Transbond XT y Transbond™ MIP) en dos condiciones del esmalte, seco y contaminado con saliva artificial. **Materiales y métodos:** 100 premolares extraídos fueron almacenados en agua destilada a cuatro grados centígrados. Los dientes fueron limpiados, pulidos y distribuidos a conveniencia en 5 grupos, los cuales son: (1) resina compuesta en condición del esmalte seco; (2) adhesivo de cianoacrilato en condición del esmalte seco; (3) resina compuesta en condición del esmalte contaminado con saliva artificial antes del adhesivo líquido; (4) resina compuesta en condición del esmalte contaminado con saliva artificial después del adhesivo líquido; y (5) adhesivo de cianoacrilato en condición del esmalte contaminado con saliva artificial. Los resultados arrojaron que el sistema adhesivo Transbond XT y Transbond™ MIP obtuvo los valores de resistencia al desprendimiento más alto con brackets cementados en la superficie del esmalte seco. **Conclusiones:** El sistema adhesivo Transbond XT y Transbond™ MIP proporciono adecuada resistencia al desprendimiento *in vitro* en todas las condiciones del esmalte. El sistema adhesivo a base de cianoacrilato Smartbond obtuvo valores adecuados a la resistencia al desprendimiento en condiciones del esmalte seco, sin embargo, obtuvo los valores más bajos en condiciones del esmalte contaminado con saliva artificial, no adecuados para la ortodoncia, e inclusive algunas muestras no fueron cementados con éxito *in vitro* bajo dichas condiciones.

Key words: Hydrophilic adhesive, orthodontic bracket, shear bond strength, cyanoacrylate adhesive, Smartbond.
Palabras clave: Adhesivo hidrofílico, bracket ortodóncico, prueba de cizalla, adhesivo de cianoacrilato, Smartbond.

INTRODUCTION

BIS-GMA (bisphenol-glicidil-methacrylate) resins were successfully introduced in the 1960's and then applied in clinical practice as orthodontic adhesives,[1] developing an organic molecule polymer with less dimensional changes and that the addition of inorganic particles further reduces the dimensional deformation thus increasing its resistance. This blend of organic material and inorganic material treated

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with a functional organic silane in order to be able to bond with the organic material is called composite resin,[2] becoming the most used bonding technique in contemporary orthodontics.

The mechanical union effectiveness of conventional composite adhesives to the enamel requires that the enamel is completely dry after etching to allow the penetration of the hydrophobic primer and achieve an adequate retention. Humidity contamination (by gingival crevicular fluid or water) reduces the adhesion strength significantly and is considered the most common cause of adhesion failure of composite resins.[3] While some manufacturers claim an acceptable performance of their intensive hydration products in a humid environment, others introduce active humidity adhesives. Recently a new cyanoacrylate adhesive (Smartbond, Gestenco International, Gothenburg, Sweden), was approved by the Food and Drug Administration for use in orthodontics in 1999. This adhesive system removed the application of liquid adhesive and the photocuring steps in addition to reducing the acid etching time to 10 seconds. According to the manufacturer the presence of humidity and pressure acts as an activator of the polimerization reaction.[4]

In 1966, in the Department of Orthodontics Eastman Dental Center,[5] a direct bonding technique was developed and used for the first time in several patients. The adhesive resin was the same used in the earlier experiments of Cueto and Bounocore for sealing pits and fissures. This experiment was carried out to see whether it was feasible to bond a bracket directly to the enamel of the teeth without the use of orthodontic bands. The adhesive consisted in a methyl-2-cyanoacrylate liquid monomer (Eastman 910, Eastman Kodak, Rochester, N.Y.) and a silicate filling.[5]

A disadvantage of bracket direct bonding has been the humidity control in the oral cavity, that is to say that a dry field is of the utmost importance for a successful adhesion. In response to the needs that an orthodontist faces under humid environments that are difficult to control, manufacturers have developed hydrophilic adhesives. This suggests the possibility of obtaining success in the direct bonding in enamel surfaces contaminated with humidity.

This protocol aims to determine the variations in the resistance to shearing forces of two adhesion systems: a cyanoacrylate-based resin, Smartbond (Gestenco International, Guthenburg, Sweden) in two conditions of enamel surface: dry and moistened with artificial saliva and a resin with an organic component Bis-GMA, Transbond TX (3M Unitek) with an hydrophilic adhesive (MIP, 3M Unitek, Monrovia, Calif) in two enamel conditions: dry and moistened with artificial saliva, the latter in two moments of contamination. This is useful when considering the adhesive material in cases of poor humidity control that do not allow an ideal isolation at the bonding site thereby optimizing results while maintaining low costs and time of attention in the dental chair; that alone justifies this need.

MATERIALS AND METHODS

100 caries-free premolars, extracted for reasons beyond our study and with the informed consent of the patient, were used. The teeth were washed with tap water after their extraction to eliminate traces of blood. Subsequently they were stored in distilled water that was changed regularly to prevent deterioration and were kept at a 4 degrees Celsius temperature until the time of bonding to the brackets. In no case the teeth remained stored more than six months after the extraction.[6] The inclusion criteria for tooth selection were: intact enamel without cracks caused by the extraction prcedure, without caries and not have undergone any previous treatment with chemical agents (for example, the hydrogen peroxide).[6]

The orthodontic adhesive systems used were:

1. Smartbond (Gestenco Internacional, Gothenburg, Sweden). Smartbond is a cyanocrilate esther. Its composition is 85-90% ethyl-cianocrylate, 5-10% polimethyl metacrylate, amorfous silica 5-10% and 0.1-0.5% hydroquinone. The etching gel is 37% phosphoric acid in a gel of amorfous silica.[4]
2. Transbond XT and Transbond™ MIP Moisture Insensitive Primer (3M Unitek, Monrovia, California). Transbond TX is a hybrid resin of photopolymerization. The basis of the resin is Bis-GMA and TEGDMA in a proportion of 1:1, with 82% of silica particles of 3 m. MIP adhesive consists of polialquenoic acid with functionalised methacrylate copolymer that form a copolymer and hydroxymethyl methacrylate. The etching gel is 35% phosphoric acid in an amorphous silica gel.

100 metal premolar brackets (Bracket Std EdGw, bicuspid, Ormco) with an average bracket base area of 10.24 mm^2 were used. For the brackets bonding tests with the adhesive systems Transbond XT and Transbond™ MIP Moisture Insensitive First, it was necessary to use a wired photopolimerization unit. The photopolimerization unit was tested at the beginning of bracket placement and every 10 samples. The potency was assessed with the radiometer.