Original Article

The Use of Ormocer as an Alternative Material for Bonding Orthodontic Brackets

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Abstract: As new adhesives, composite resins, and bonding techniques were introduced, orthodontists adopted some of these innovations and added them to their armamentarium. The purpose of this study was to compare the shear bond strength (SBS) of two adhesive materials; one with an organically modified ceramic matrix, Admira (Voco, Cuxhaven, Germany) and another that contains the traditional Bis GMA matrix namely Transbond XT (3M Unitek, Monrovia, Calif). The new materials have a lower wear rate and are more biocompatible than traditional composites. Forty molar teeth were randomly divided into two groups: 20 teeth bonded with the Transbond adhesive system and the other 20 teeth with the Admira bonding system. Student's *t*-test was used to compare the SBS of the two adhesives. Significance was predetermined at $P \leq .05$. The results of the *t*-test comparisons ($t = 0.489$) of the SBS indicated that there was no significant ($P = .628$) difference between the two adhesives tested. The mean SBS for Admira was 5.1 ± 3.3 MPa and that for Transbond XT was 4.6 ± 3.2 MPa. It was concluded that the new material, Ormocer, which is an organically modified ceramic restorative material can potentially have orthodontic applications if available in a more flowable paste. These new materials are more biocompatible and have lower wear rate including bonding orthodontic brackets to teeth. (*Angle Orthod* 2004;75:106–108.)

Key Words: New adhesive; Ormocer; Brackets; Shear bond strength

INTRODUCTION

Since Buonocore introduced the acid etch bonding technique in 1955, the concept of bonding various resins to enamel has developed applications in all fields of dentistry[1] including the bonding of orthodontic brackets.[2–8] There are a number of other factors that can potentially contribute to the bond strength between the enamel and the orthodontic bracket including the type of enamel conditioner, acid concentration, length of etching time, composition of the adhesive, bracket base design, the bracket material, the oral environment as well as the skill of the clinician.[1–14]

As new adhesives, composite resins, and bonding techniques were introduced,[15–18] orthodontists adopted some of these innovations and added them to their armamentarium. Improvements to the composite resins included altered filler packing, higher filler levels, and hybrid filler particles. These changes enhanced the mechanical properties, reduced coefficient of thermal expansion, introduced radio-opaque materials, reduced polymerization shrinkage, and improved esthetics. More recent advances included the introduction of flowable composite resins and also condensable ones that behave clinically like amalgams. These composite resins are characterized by a higher filler load, improved filler matrix interface, and improved handling properties.[19]

Although the resin matrix significantly influences the properties of composite resins, it is interesting to note that there were few fundamental changes in that aspect of the restorative-adhesive system since the introduction of dimethacrylates in the form of bisphenol A glycidyl dimethacrylate (Bis GMA). This is because the material has proved to be relatively reliable for both restorative and orthodontic purposes.

On the other hand, some recent research indicated that,

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the bisphenol A component in the structure of the monomer Bis GMA is suspected of having an estrogenic effect whereas the Bis GMA itself has also been found to be cytotoxic in a number of cell culture systems.[20,21] In an attempt to overcome some of the limitations and concerns associated with the traditional composites, a new packable restorative material was introduced called Ormocer, which is an acronym for organically modified ceramic technology. Ormocer materials contain inorganic-organic copolymers in addition to the inorganic silanated filler particles. It is synthesized through a solution and gelation processes (sol-gel process) from multifunctional urethane and thioether(meth)acrylate alkoxysilanes. Ormocers are described as 3-dimensionally cross-linked copolymers. The abundance of polymerization opportunities in these materials allows Ormocers to cure without leaving a residual monomer, thus having greater biocompatibility with the tissues. Ormocer was formulated in an attempt to overcome the problems created by the polymerization shrinkage of conventional composites because the coefficient of thermal expansion is very similar to natural tooth structure.

Laboratory testing of Ormocer materials suggests a significantly lower wear rate compared with composites.[22] On the other hand, Cattani-Lorente et al[23] found that the shrinkage of Ormocer was equal to that of hybrid composites despite having less filler content. The authors attributed their findings to the difference in the resin matrix of Ormocer. As a result, it was suggested that the advantages of Ormocer include low shrinkage, high abrasion resistance, biocompatibility, and protection against caries.[24]

The purpose of this study was to compare the shear bond strength (SBS) of two adhesives, one with an organically modified matrix, Admira (Voco, Cuxhaven, Germany), and another that contains the traditional Bis GMA matrix, namely Transbond XT (3M Unitek, Monrovia, Calif).

MATERIALS AND METHODS

Teeth

Forty freshly extracted human molars were collected and stored in a solution of 0.1% (wt/vol) thymol. The criteria for tooth selection included intact buccal enamel, not subjected to any pretreatment chemical agents such as hydrogen peroxide, no cracks due to the pressure of the extraction forceps, and no caries. The teeth were cleansed and then polished with a pumice slurry and rubber prophylactic cups for 10 seconds. All teeth were thoroughly washed and dried.

Brackets used

Forty maxillary right central incisor brackets (Victory Series, 3M Unitek) were used. The average surface area for the bracket base was 12.2 mm^2. The surface area was the average obtained from measuring five brackets.

Bonding procedure

The 40 teeth were randomly divided into two groups.

Group 1 (Transbond XT adhesive system): Twenty teeth were etched for 15 seconds with 35% phosphoric acid, washed with a water spray for 10 seconds, dried to a chalky white appearance, and the sealant applied to the etched surface. The adhesive was then applied to the bracket base and placed on the tooth and light cured with a halogen light for 20 seconds.

Group 2 (Admira bonding system): Twenty teeth were etched with vococid (35% orthophosphoric acid) for 20 seconds. The teeth were then rinsed with a water spray for 10 seconds and dried with an oil-free air source for 10 seconds until the enamel surface of the etched teeth appeared to be chalky white in color. The sealant was then applied to the tooth surface using a disposable brush and left for 30 seconds. The sealant was lightly dispersed with an air jet, and then light cured with a halogen light for 20 seconds. Ormocer restorative paste was then applied to the bracket base, and the brackets were placed on the teeth and light cured for 20 seconds.

After placing the brackets on each tooth, a 300-g force was applied using a force gauge (Correx, Bern, Switzerland) to ensure a uniform adhesive thickness.

SBS testing

The teeth were embedded in acrylic in phenolic rings (Buehler, Ltd., Lake Bluff, Ill). A mounting jig was used to align the facial surface of the tooth perpendicular to the bottom of the mold and its labial surface parallel to the force during the shear strength test. Within half an hour from the initial bonding, an occlusogingival load was applied to each bracket, producing a shear force at the bracket-tooth interface. This was accomplished by using the flattened end of a steel rod attached to the crosshead of a Zwick Universal Test Machine (Zwick GmbH & Co., Ulm, Germany). A computer connected electronically to the Zwick test machine recorded the results of each test in megapascals. SBSs were measured at a crosshead speed of 5 mm/min.

Statistical analysis

Descriptive statistics including the mean, standard deviation, minimum and maximum values were calculated for the two groups evaluated. Student's *t*-test was used to compare the SBSs of the two adhesives. Significance was predetermined at $P \leq .05$.

RESULTS

SBS comparisons

The results of the *t*-test comparisons ($t = 0.489$) of the SBS indicated that there was no significant ($P = .628$) dif-

TABLE 1. Descriptive Statistics and the Results of Student's *t*-test Comparisons of the Shear Bond Strength (in MPa) of Admira and Transbond XT systems[a]

Groups	N	$\bar{X}$	SD	Range
Admira	20	5.1	3.3	0.2–13.0
Transbond XT	20	4.6	3.2	0.4–11.1

[a] $t = 0.489$; $P = 0.628$.

ference between the two adhesives tested. The mean SBS for Admira was 5.1 ± 3.3 MPa and that for Transbond XT was 4.6± 3.2 Mpa (Table 1).

Bracket failure

During debonding, three out of 20 (15%) brackets bonded with Admira failed without registering any force on the Zwick recording. These three brackets were excluded from the calculations. None of the brackets bonded with Transbond XT had a similar failure mode.

DISCUSSION

Manufacturers are continuously introducing new restorative and adhesive systems to the dental profession that are more reliable, ie, stronger, adhere better, less liable to leak at the margins, and easier to handle. Orthodontists have benefited from these new innovations including the use of self-etching primers, stronger adhesives, and more efficient light sources. It has been suggested that the newly introduced Ormocer restorative materials have a lower wear rate, low shrinkage, and greater biocompatibility than regular adhesives.[19–24] The present findings indicated that within the initial half an hour after bonding, the new adhesive Admira can achieve SBS values that are similar to those obtained with Transbond XT. On the other hand, as currently formulated, the thick adhesive paste of Admira needed to be forcibly pushed into the bracket base during the bonding process for it to engage the retention pad. This difficulty in handling the material might explain why three out of 20 brackets (15%) failed to register any force value during testing. As a result, it is suggested that for orthodontic usage, the manufacturer should consider reformulating the composition of Admira to make it into a relatively thinner and more flowable paste that can readily penetrate the mesh of the bracket base. Until the more flowable version of this new organically modified ceramic restorative system is developed, Ormocer should only be considered as potentially useful for bonding orthodontic brackets.

CONCLUSIONS

New materials that are being introduced in operative dentistry can potentially have orthodontic applications. One such material is Ormocer, an organically modified ceramic restorative material. These materials are more biocompatible, have lower wear rate, and can potentially be used to bond orthodontic brackets to teeth.

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