Shear bond strength of restorative materials to deciduous teeth

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Received on 12/5/00
Approved on 8/10/00

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ABSTRACT

Shear bond strength of Chelon Fil (ESPE), Vitremer (3M), Compoglass-F (Vivadent) and Z100 (3M), was evaluated on deciduous teeth. Forty primary canine teeth had their bucal enamel surface ground flat (grit 600) and the materials were applied following the instructions of the manufacturers. Bond strength was measured using a Instron Universal Testing Machine at a cross-head speed of 0.5mm per minute. The results showed that Chelon Fil had the lowest bond strength (3,42 MPa). Vitremer and Compoglass-F shear bond strength were very close (9,02 MPa and 8,38 MPa), but smaller than Z100 strength (13,34 MPa). (p<0,01)

Key words: Shear bond strength, deciduous tooth adhesion, glass ionomer cement

INTRODUCTION

Resin-modified glass ionomers cements (RMGIC) and the Composite resins modified by polyacids (compomers) are adhesive restorative materials widely used in odontopediatry. After modifications that occurred in the patterns of the development of caries lesions in the population, it was made possible an early approach to the lesions and, thus, more conservative preparations. With the advance in technology, materials with practical and rapid manipulation, with superior properties, have become more appealing to practitioners. However, studies on these materials in hard tissues of deciduous teeth are scarce (Kiellbassa et al, 1997) in opposition to studies in permanent teeth. Furthermore, a wide variety of materials with distinct formulations that may show different behavior on dental tissue is available. Tests of shear bond strength with RMGIC present variable results, superior or not to those conventional, and comparison of results of these studies is difficult due to differences in the methodology employed (Sidhu & Watson, 1995).

Since the clinical success of an adhesive restoration depends on the bond strength of materials to the tooth structure and taking into consideration the scarce number of studies with materials applied to the mineralized structures of deciduous teeth, this study proposed to evaluate, *in vitro* and in deciduous teeth, the shear bond strength of three restorative cements available in the Brazilian market, the RMGIC Vitremer[1], the compomer Compoglass-F[2] and the conventional glass ionomer cement Chelon-Fil[3] as well as the composite resin Z100[4].

MATERIAL AND METHODS

The preparation of teeth

Forty deciduous canines extracted due to orthodontic reasons or due to advanced rizolisis although without reabsorption of the coronal dentin were selected. Teeth were keep on neutral buffered formaldehyde furnished by the Department of Biochemistry of the School of Dentistry of Bauru-USP for a period no longer than 6 months. Roots were sectioned 2 mm from the cement-enamel junction with a diamond burr in high speed cooled by air-water spray. Remains of the periodontal ligament were manually removed with Grace[5] curette. The exposed sections of root canal were cleaned with dentin spoon and closed with Herculite XRV[6] composite resin.

Group	Material	Adhesion system	Manufacturer
I	Chelon Fil	–	ESPE Dental-Medizin, Seefeld, Germany
II	Vitremer	Product's primer	3M/Dental products, St. Paul, MN, USA
III	Compoglass-F	Syntac SC	Ivoclar/Vivadent, Ellvangen, Germany
IV	Z100	Single Bond	3M/Dental products, St. Paul, MN, USA

FIGURE 1 – Identification of materials used in each group.

Shear bond strength test

The selected 40 teeth were maintained with the vestibular aspect facing the bottom of the cylindrical matrixes of 25 mm height and made of a PVC[7] tube with $^3/_4$ inch of diameter, for inclusion in epoxy resin[8]. After

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1. 3M/Dental products, St. Paul, MN, USA

2. Ivoclar/Vivadent, Ellvangen, Germany

3. ESPE Dental-Medizin, Seefeld, Germany

4. 3M/Dental products, St. Paul, MN, USA

5. Dulflex, S.S. White Art. Dent. Ltda

6. Kerr

7. Tigre, Brazil

8. T-208 Redefibra, SP, Brasil

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polimerization of the epoxy resin (24 hours), the face of the cylinder containing the vestibublar side of the canine was hewed with a number # 300[9] file in a polishing machine[10] cooled by water till the exposition of a enamel surface with circa 2 mm of diameter. Afterwards, with a file of the same brand but with granulation 600, the hewing process was continued till exposure of the enamel surface of circa 3 mm of diameter.

On the enamel surface it was put an adhesive tape[11] with a circular perforation of 2 mm of diameter which were produced by a rubber dam[12] perforator. This procedure was necessary to limit the area of adhesion of the specimens, thus preventing the overflow of material, which could influence the results of adhesion tests.

Included teeth were randomly allotted in four groups in order to be submitted to the specific treatments for adhesion tests as follows:

• group I: the enamel was etched with 40% polyacrylic acid for 8 seconds; afterwards it was washed with air-water spray for 30 seconds and dried with an air flow.

• group II: the enamel was etched with 40% polyacrylic acid for 8 seconds, dried with an air flow before the primer was applied for 30 seconds. It was dried with an air flow and then it was photopolymerized for 30 seconds.

• group III: the enamel was etched with 37 % phosphoric acid for 15 seconds and washed for 20 seconds with an air-water spray. The excess of water was removed with an absorbent paper and the surface of the enamel was left humid for further application of the Syntac SC adhesive for 20 seconds, removal of the excess with a flow of air and photopolymerization for additional 20 seconds. The Syntac SC was applied twice as instructed by manufacturers.

• group IV: the enamel was etched with 37 % phosphoric acid for 30 seconds, washed and the excess of water removed as in the previous group. It was applied Single Bond adhesive and photopolymerized for 30 seconds.

The cylinders containing the treated teeth were adapted to a device able to maintain them juxstaposed to a bipartite teflon matrix forming the cylindrical specimen with 2 mm of diameter and 6 mm in length.

To group I the Chelon-Fil cement was manually espatulated in a glass plate in the proportion of one measure that accompanies the product to one drop of the liquid and placed in the matrix by a C-R[13] syringe in one dosage. The material was kept protected by a polyester matrix for five minutes. After that, the matrix was removed and the material protected by a layer of solid vaseline.

To group II, a portion of the measure of Vitremer cement powder was mixed to a drop of the liquid and the spatulation proceed for 30 seconds in a glass plate with a plastic spatule furnished by the manufacturer. The material was placed in the matrix with ad C-R syringe and photopolymerized for 60 seconds. After the removal of the matrix, the polymerization was further continued for 60 seconds with a flash of light directed to the base of the cylinder.

9. Norton, São Paulo, Brazil

10. Fortel – FPL; São Paulo, Brazil

11. 3M, Brazil

12. Ivory, Brazil

13. Centrix Inc.USA

To group III, Compoglass-F was placed in the matrix in three portions of circa 2 mm with a C-R syringe which were polymerized for 20 seconds each.

To group IV, the matrixes were filled with Z100 resin in three portions of circa 2 mm which were polymerized for 20 seconds each.

Afterwards, the specimens were kept stored in deionized water at 37ºC for 24 hours. The specimens were then positioned in an adequate device and mounted in an Universal Essay Machine[14] for shear bond strength test through a point with a slot shaped extremity 0.5 mm tick mounted into the cylinder base at a speed of 0.5mm/min. The resistance to the shear bond was recorded in Kgf and, afterwards, results were converted into Mpa since the cylinder diameter was standardized in 2 mm.

Results were also analyzed by statistic tests of variance analyzes to a fixed model criteria to verify the presence of statistic difference among groups and, afterwards, submitted to Tukey and Kramer's comparison test to assess among which groups there existed differences. The significance level was determined at 1%.

RESULTS

The means and standard deviation for shear bond strength of tested materials are shown in TABLE 1.

TABLE 1 – Mean standard deviation and result of the statistical test for restorative materials according to shear bond strength (MPa).

Chelon-Fil	Vitremer	Compoglass	Z100
3.42 ± 1.52 a(1)	9.02 ± 4.04 b	8.38 ± 3.72 b	13.34 ± 5.91 c

(1) Means followed by a same letter do not differ ($p>0.01$) according to the Test of Tukey-Kramer.

The difference among means may be better seen in the graphic of FIGURE 2.

Through the statistic test of variance analyzes it is possible to observe the statistically significant difference in the shear bond strength of tested materials($p>0.01$). However, Compoglass-F (8.375 MPa) e Vitremer (9.018 MPa) were the only materials not to show significant difference as demonstrated by the Tukey-Kramer's test in TABLE 1 ($p>0.01$).

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14. Kratos, São Paulo, Brazil

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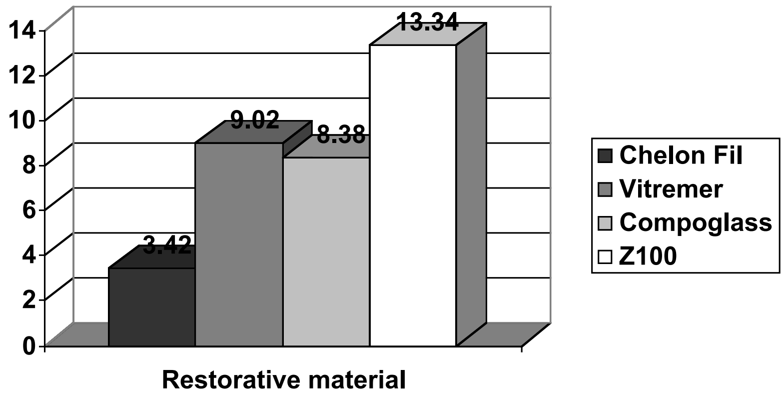

FIGURE 2 – Mean shear bond strength of materials used on the enamel of deciduous teeth in MPa.

DISCUSSION

The glass ionomer cement (GIC) was developed in the early 70's by Wilson; Kent but it succeeded among clinicians only in the last few years. During these years this material had its formula modified, resulting in improved mechanical resistance, increased tranlucency and, more important, decreased hardening time (Yap et al., 1994). GIC are complex materials and no commercial product is equal to the others. They derive from aqueous polymeric acids and a vitreous component, commonly the sylicate of aluminiumfluoride. The composition of the glass, polymer and additives may vary. However, all of them are acid-basic reactive cements (Sidhu & Watson, 1995). In the last years, the evolution in the formulation of GIC led to the introduction of a hybrid version of this material, which is photopolymerizable. This type of glass ionomer cement (RMGIC) was developed in the attempt to solve the problem of sensitivity to humidity and initial low mechanical resistance associated to conventional GICs, aiming at preserving their main properties such as the fluoride release and adhesiviness to the dental structure (Cortés et al., 1998; Sidhu & Watson, 1995). In the RMGIC the basic acid-base reaction is supplemented by a second process of hardening of the material, which is initialized by light. In other words, they are GIC with addition of small amounts of organic components such as HEMA or Bis-GMA. More complex materials have been developed by modification of the polyacid with photoactivable colateral-chains. However, they remain as GIC due to their ability to hardening in the absence of light even though a little slower than the conventional GIC. Formulations available today varies according to the manufacturer but the amount of resin at the end of the restoration should range from 4.5% to 6% (Sidhu & Watson, 1995). Only one of the tested cements complies with this condition – the Vitremer. The other (Compoglass-F) should not be classified in the same category of resin-modified glass ionomer cements or hybrid (RMGIC) since it does not shows the reaction of acid-base self-gelification reaction which occurs without photoinitiation. Furthermore, when hardened, it does not show the typical properties of a GIC. However, in the present study, results of shear bond strength test of these materials were quite similar.

Yu et al., in 1995, compared the resistance of the bond resistance in four fluoride releasing cements, among them the Vitremer and the Variglass/Caulk Dentisply. The Variglass compomer showed the worst results regarding bondness to dentin. On the other hand, Triana et al., in 1994, studying the bounding of cements to dentin such as Vitremer and Variglass observed, in opposition to YU et al., that this material presented figures superior to Vitremer.

Dhummarungrong; Moore; Avery, in 1994, studied comparatively the mechanical properties of GICFuji II, Ketac-silver cement, Variglass Z 100, a composite resin for posterior teeth. In relation to the tests of resistance to compression, diametral tension and transverse fracture, the compomer Variglass showed the worst results but had the best performance in relation to the brush abrasion test.

Results of this study demonstrated that the conventional GIC Chelon Fil showed the smaller values of shear bond strength among the studied materials, and the composite resin Z 100, the greatest (FIGURE 2).

In regard to the resistance to shear bond strength of Compoglass-F in dentin, Jumlongras; White in 1997, did not observed differences between primary and permanent teeth. On the other hand, for Herculite, a composite resin, the resistance in primary teeth was smaller than in permanent teeth. These authors obtained figures around 11.94 Mpa to shear bond strength for Compoglass-F. With the same material El-Kalla; Garcia-Godoy, in 1998, obtained 16. 9 MPa and 23.8 Mpa with Vitremer, which are values superior to 13 MPa and 20.3 MPa obtained with permanent teeth. These figures are superior to those obtained with test of shear bond strength for the Z 100 composite resin with dentin adhesive Scotchbond Multiporpose to the enamel of primary teeth (11.18 MPa) reported by Hallet; Garcia-Godoy; Trotter, in 1994, and by the present study with Z 100 resin and the Single Bond adhesive (13.34 MPa) (FIGURE 2).

Cortés et al., in 1998, observed an average of 7.24 MPA of shear bond strength to Compoglass-F applied to the enamel of deciduous teeth previously etched with phosphoric acid. This figure is quite close to the 8.38 MPa obtained in the present study (FIGURE 2).

Kiellbassa; Wrbas; Hellwig, in 1997, reported that the bonding resistance of the compomers Dyract and Compoglass-F to the dentin of deciduous teeth is minimal in the first 15 minutes, an average 2.09 Mpa.

According to the tests, it was observed a similar performance with the RMGIC Vitremer and the compomer Compoglass-F (TABLE 1). However, these materials showed other properties that are different and that should be taken into consideration. For instance, the solubility of Vitre-

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mer is higher than that of the Compoglass-F. On the other hand, its fluoride release in also higher (Bertachini, 1999; Costa, 1995) and could form a layer enriched by fluoride ions in the adjacent enamel, which become more resistant to acid demineralization (Wallsetal., 1988)·

The manipulation of Vitremer, in the powder/liquid proportion instructed by the manufacturer is difficult because the material becomes quite thick turning the syringe injection difficult. However, this proportion should not be modified without criteria since the solubility of this material increases as the amount of liquid in the mixture is increased (Quackenbush et al., 1988). Another important step in the technique for the Vitremer, and that should not be neglected is the application of the fluid resin at the end of the restoration (Gloss). In fact, Sidhu; Serriff; Watson, in 1997, demonstrated that despite the fact that the RMGIC are prone to dehydration and absorption even after a period of 6 months to one year, it could show superficial cracks and marginal disadaptations (Sepet et al.,1997). This phenomenon suggests that the Gloss should be applied again from time to time in order to minimize such problems.

The fluoride release of Vitremer (Bertachini, 1999; Costa, 1995), and its antimicrobian activity(Costa,1995) are characteristics highly desirable in odontopediatry, mainly in cases of great caries activity. This characteristic associated to the satisfactory results reported in this study, can recommend it for deciduous teeth in many situations.

Since it resembles closely to composite-resin, the Compoglass-F may be indicated to larger cavities and in posterior teeth. Some authors do recommend it to class II cavities in deciduous teeth (Cortés et al., 1998; Tulunoglu,1998). However, this material should only be indicated to patients with no intense decay activity.

Another advantage of Compoglass-F is the easy manipulation. There is no need of mixture and spatulation. The material is ready to use, packed in portions and in a device that is connected to the syringe for application. These technical readiness are quite convenient, mainly in the treatment of children.

CONCLUSIONS

Results obtained with the methodology of this study may lead to the following conclusions:

- Z100 has greater shear bond strength than all other materials ($p<0.01$).
- Vitremer and Compoglass-F shows similar resistance regarding shear strength ($p<0.01$).
- ChelonFil showed smaller shear bond strength than all other materials ($p<0.01$).

ACKNOWLEDGEMENT

To CAPES for the financial support that made this study possible.

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