Tensile Bond Strength Evaluation of Two Adhesive Cements Used for Bonding Orthodontic Metal Brackets to Porcelain Fused-to-metal Crowns

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In order to obtain an ideal smile design for our today subjects, more often the dental treatment requires interdiciplinarity. Recent advances in dental materials and techniques promote the opportunity of bonding orthodontic attachments to surfaces other than enamel, like porcelain crowns, veneers, or bridges. This study aims to compare tensile bond strengths of metal brackets bonding to porcelain fused-to-metal crowns, using two different luting cements (RelyX™ Unicem U200 by 3M ESPE, respectively Blugloo by Ormco) and the same surface conditioning system, as well as to determine the findings' statistical value. The results evaluated by ANOVA, Tukey and Kruskal-Wallis tests indicated no statistically significant differences among the two cements in terms of tensile bond strength.

Keywords: metal brackets, ceramic crowns, tensile bond strength, luting cements

The remarcable evolution of dental materials and techniques in the past decade has enabled great possibilities regarding esthetic oral rehabilitation. Besides predictable correction of malpositioned teeth, orthodontic treatment includes solutions for achieving an ideal smile design.

To align malpositioned teeth, orthodontists use brackets bonded on the facial surface of the teeth, usually on both arches. In cases of existing prosthetic restorations, orthodontic treatment with fixed appliances relies on bonding metallic (stainless steel) brackets to porcelain fused to metal crowns. Recent advances in materials and techniques suggest that direct bonding of orthodontic attachments to surfaces other than enamel may now be possible. An important step in orthodontic treatment was the use of diacrylic composite resins which proved to be similar to those used in odontology [1].

Orthodontic brackets can be bonded to ceramic surfaces with chemical, light or dual cure systems, which proved to be equally successful if their inherent variables are controlled [2]. Compomer and resin materials designed for adhesive use are anhydrous and have silanized, unreactive fillers [3]. Resin cements, in particular, are well suited for adhesive procedures in restorative, prosthetic and/or orthodontic dentistry, clinical success, however, can be compromised by the technical challenges associated with their use**.** Accordingly, tensile bond strength is a main determinant of the adhesive system election and implicitly of treatment success, since adhesion implies having retention between two surfaces with minimal or no requirement for mechanical factors [4, 5].

The objective of this study was to compare the tensile bond strength of metal brackets bonding to metal ceramic crowns using two different cements and surface treatments.

RelyX™ Unicem U200 by 3M ESPE is a dual-curing, self-adhesive universal resin luting cement for indirect ceramic, composite or metal restorations, without previous acid conditioning and bonding of abutment teeth. Its essential characteristics are high dimensional stability and very good adhesion to the tooth structure [6]. Compared to multi-step composite cements, its qualities are: strength, moisture-tolerance, retard fluoridation effect and esthetics, being available in various shades.

Blugloo by Ormco is a light cure bonding system. It is the first adhesive that provides a chameleonic effect, its color and chemistry being optimized for aesthetic brackets. The colour contrast of Blugloo during bonding facilitates fast, accurate bracket placement, eliminating drift, and eases removal of unwanted flash. As Blugloo warms to body temperature, the colour virtually disappears, remaining clear throughout treatment. According to the manufacturer, Blugloo ensures reliable bond strengths in most challenging cases [7].

Experimental part

Materials and methods

Sixteen porcelain-fused-to-metal crowns were randomly assigned to two different groups, 1 and 2, each group containing eight specimens. Both groups underwent the same preparation protocol prior to bracket bonding: ceramic surfaces were etched with 10% hydrofluoric acid (Angelus), followed by application of ceramic primer and adhesive. The pre-activated silane (Silano by Angelus, Brazil) was chosen because of its recognized enhancement of ceramic/ cement interface bond strength.

In group 1, brackets were bonded with Relyx U200 dual cure resin cement, while in group 2, bracket bonding was performed using Blugloo light cure composite.

Static tensile tests were performed using a static universal testing machine Zwick Proline Z005, with a maximum load of 5 kN. The stiff load-frame and large connecting surfaces reduce the inclination angle of the crosshead under load, enabling very precise alignment and application of force to the specimen and at the same time being of great advantage for tensile/ flexure testing. The wide base-crosshead provides optimum securing and retaining, while continuous standard slots enable individual

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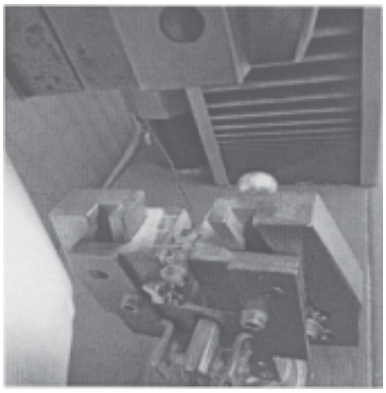

Fig. 1. Tensile strength measurement were performed with the static universal testing machine Zwick Proline Z005 with a maximum load of 5 kN

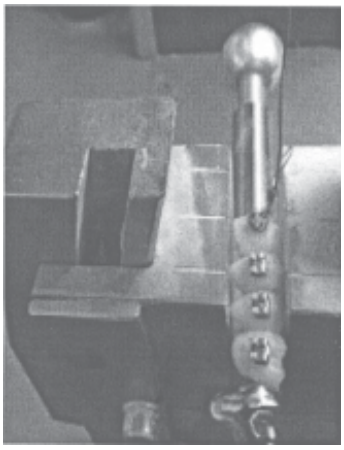

Fig. 2. The load force was applied using fixed wires to the metal brackets

mounting of specimen materials, fixtures, safety devices and accessories.

The bonded specimens (fig.1) were secured by grips to the lower load-frame, and load force was applied using wires fixed to the metal brackets, as shown in figure 2. Tests were conducted at a room temperature of 20 degrees Celsius with a load speed of v = 1 mm/min. The load - displacement curve was recorded during tests, obtaining the bond breaking load Fmax. Further calculations revealed the bond strength $\sigma = Fmax/A$, A representing the bracket/ceramic bonding interface area. Figure 3 displays a typical load - displacement diagram recorded during tests. The displacement of 6 mm is explained by measuring the load wire deformation in addition to the debonding deformation.

The recorded data were subject to one-way ANOVA, Tukey and Kruskal-Wallis tests.

Results and discussions

The experimental results are presented in table 1. Measurements revealed a tensile bond strength of 5.18 MPa for group 1, representing the average results for Relyx

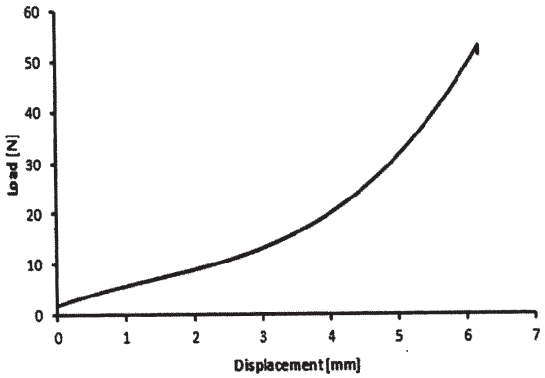

Fig. 3. Typical load - displacement diagram

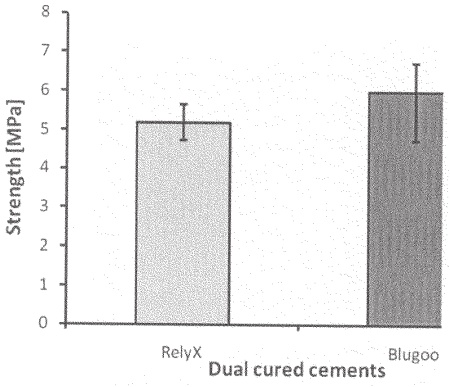

Fig.4. Graphical analysis of the tensile bond strength for both groups

U200 dual cure resin cement, and of 5.97 MPa for group 2, representing the average results for Blugloo light cure composite (fig.4). According to the findings above, it can be stated that there were no significant differences between the two test groups ($P<0.01$).

Numerous methods and materials have been used to increase the bond strength of orthodontic brackets to the porcelain surface [8-12]. Current research suggests that brackets bonded with silane coupling agents and hydrofluoric agent or phosphoric agent have sufficient bond strength for orthodontic treatment [10, 13-15]. An equally important role is played by a broad spectre of adhesive cements in bonding orthodontic attachements to metal-ceramic crowns, conferring good adhesion even in most difficult cases.

RelyX Unicem U200 by 3M ESPE is a dual-cured universal adhesive cement, which proved to be suitable for efficient orthodontic bonding because of its one step adhesion

Cement type	Bonding area [mm^2]	Maximum load [N]	Strength [MPa]	Mean Strength [MPa]
RelyX	10.816	54.2	4.87	5.18
	9.080	54.0	4.99	
	12.145	73.3	8.07	
	11.018	55.0	4.53	
	11.278	52.4	4.76	
	11.344	54.3	4.81	
	12.634	53.8	4.74	
	10.816	58.6	4.64	
Blugoo	12.956	77.5	5.98	5.98
	11.340	73.3	6.46	
	12.038	68.9	5.72	
	11.512	70.3	6.11	
	11.766	71.8	6.10	
	11.178	66.9	5.98	
	11.076	74.5	6.73	
	11.268	53.5	4.75	

Table 1

procedure [16] and its long-term stability, low expansion and adequate tensile strength which is particularly requested when cementing orthodontic brackets. A study conducted by Liu &all [17] investigated and confirmed that the bond strength of RelyX Unicem was significantly higher than that of other 3 resin cements which displayed high percentage of cohesive failures .

Blugloo by Ormco is a light cured resin cement. The urethane-modified dimethacrylate resin produces a refined molecular structure that results in a tougher, less-brittle polymer, providing added bond strength, high-tack paste and cleaner debonding procedures [7].

First reported clinical use of visible light cured composite resin was made by Bassiouny and Grant [18] and in 1979 Tavas and Watts [19], and later Kumar & all [20] demonstrated that visible light cure resin has enough strength for use in bonding brackets**.** It is well-known that working with light cured composite is simple and has demonstrated its efficiency in the long term attaching of brackets [21].

Compared to commercial resin cements, experimental studies conducted by Li et al. in 2009 found that dual-cured composite resin cement reinforced by certain accelerators like p-tolydiethanolamine and sodium p-toluenesulfinate exhibited noticeably higher tensile bond strength [12].

Conclusions

In the present report, metal-ceramic crowns were conditioned with 10% hydrofluoric acid (HFA) prior to ceramic primer and adhesive application. Two different cements were used for bracket bonding: the dual-cured resin cement RelyX U200 for the first group, and the light cure cement Blugloo for the second one. Tensile bond strength was tested by means of the universal testing machine Zwick Proline Z005. This method was elected in order to emphasize that RelyX U200, 3M ESPE can be successfully used in orthodontics. Overall, no statistically significant differences between self-adhesive and light cure cements have been found.

Since there were no signifficant differences of tensile bond strength between the two materials, it can be concluded that both dental materials may be recommended for orthodontic bracket bonding to ceramic surfaces, with equally succesful results. However, further testing on an increased number of specimens may be considered for more accurate data.

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