

Gingival compound resin and feldspar ceramic: shear strength of different adhesion systems and surface treatment

Abstract

The aim of this study is to assess the shear strength between gingival compound resin Amarilis Gingiva (Voco, Germany) and a feldspar ceramic Creation (Willi Geller International, Austria) at the bond surface. To this end, the test considers two adhesive systems: Adper Scotchbond[®] Multi-Purpose Plus, (3M ESPE, USA) and Adper Single Bond[®] Plus (3M ESPE, USA), and two surface treatments: with and without aluminum oxide 50 µm blasting. The specimens were distributed among four groups: G1 (blasting and Scotch Bond Multipurpose); G2 (without blasting and scotch Bond Multipurpose); G3 (blasting and Adper Single bond); G4 (without blasting and Adper Single Bond). The blocks with the ceramic were primed with hydrofluoric acid at 10% and the compound resin was applied. The test specimens were subjected to thermal cycling for 5,000 cycles at 5°C, 37.5°C and 55°C, and then tested for shear strength. Data were organized in a spreadsheet and analyzed with one-way ANOVA and Tukey's test. Here, treatment of the ceramic surface with blasting results in significant higher shear strength, regardless of adhesive type. Among the specimens submitted to blasting, the association of the adhesive 3M ESPE Adper Scotchbond[®] Multi-Purpose Plus resulted in significantly higher shear strength.

Keywords: composite resin gum, feldspathic ceramics, hydrofluoric acid

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Introduction

The influence of aesthetics on the various dentistry specialties is increasingly more relevant. Areas that historically have focused on treatments to restore oral health are currently driven to seek solutions to aesthetic interventions. Also, different specialties have sought to interact with the aim of achieving better aesthetic outcomes. Currently, the relationship between prosthesis and periodontics overcomes the need of rehabilitation and maintenance of periodontal health. The restoration procedures are significantly hindered in situations such as loss of soft and bone tissue that cause the appearance of defects, mainly in the anterior region, when surgical interventions are not possible. In these cases, dentogingival prosthetic restoration is a viable alternative for the aesthetic and functional restoring.^{1,2} Current ceramics used in dentogingival prostheses are known to be aesthetically fit since they simulate the natural color of teeth and have adequate physical properties. However, the ceramics that simulate gingival color offer a less than optimal result. The alternative choice, with a better pink aesthetic, is the gingival color compound resin. This material, however, raises questions regarding bond strength with porcelain infrastructures.³⁻⁵ The concept of adhesion has changed the dental practice, placing adhesive dentistry in constant evolution. New and improved products are constantly being introduced to the market, motivating research to unveil and compare behaviors under different conditions. However, mechanical, chemical and mechanical-chemical methods are still designed to promote an adequate irregular surface and optimize mechanical retention of the resin. The ceramic surface can be treated with acids,^{6,7} or with diamond-tipped burs and blasting.^{8,9} Given this context, the aim of this study is to analyze the bond strength between feldspar ceramic Creation (Willi Geller International GmbH, Meiningen - Austria) and the gingival compound resin Amarilis Gingiva (Voco, GmbH, Cuxhaven, Germany) using shear strength testing and thermal cycling. The analysis will consider two adhesive bond agents: 3M ESPE Adper Single Bond[®] Plus and

3M ESPE Adper Scotchbond[®] Multi-Purpose Plus with or without surface treatment (blasting with aluminum oxide of 50µm).

Proposition

The objective of this study is to assess the bond strength between feldspar ceramic Creation (Willi Geller International GmbH, Meiningen - Austria) and gingival compound resin Amarilis Gingiva (Voco, GmbH, Cuxhaven, Germany) using shear strength testing and thermal cycling. The analysis will consider two adhesive bonding agents: 3M ESPE Adper Single Bond Plus and 3M ESPE Adper Scotchbond[®] Multi-Purpose Plus, with or without surface treatment (blasting with aluminum oxide of 50µm).

Materials and methods

This study was approved by the Research Ethics Committee of the Dentistry School and Research Center São Leopoldo Mandic, under protocol 2015/0391. To manufacture the porcelain samples, feldspar porcelain powder Creation (Willi Geller International GmbH, Meiningen, Austria) was mixed with distilled water and stored in a metallic matrix with hole of 9.0 x 4.0mm. For the insertion, a 24 Duxflex spatula (SS White, Rio de Janeiro, Brazil) was used. 120 porcelain tablets were manufactured (9.0 x 4.0 mm). They were taken out of the matrix and taken to the porcelain oven Vulcano Platinium (EDG, São Carlos, Brazil) at a temperature of 600°C for 6 minutes, with heating speed of 55°C/min, under vacuum. Once reaching 910°C, the tablets were left for 1 minute without vacuum. The tablets were then left to cool at room temperature (Figure 1).

The ceramic tablets were included using ½ inch PVC tubes of 15 mm of height (Tigre, Castro, PR, Brazil) and colorless self-polymerizable acrylic resin Jet (Artigos Odontológicos Clássico Ltda., São Paulo, Brazil). The blocks were polished in a polishing machine (Politriz, Arotec, Cotia, SP, Brazil) using water sandpaper Aquaflex (Norton, Guarulhos, Brazil) with grit sizes of 320, 400, 600,

800, 1200 and 1500 for 30 seconds each at a speed of 300rpm. The ceramic blocks were randomly distributed among four groups (n=30).

1. G1 - Blasting with aluminum oxide of 50µm for 10 seconds; cleaning with absolute alcohol; priming with 10% hydrofluoric acid for 4 minutes; use of adhesive AdperScotchbondMulti-Purpose Plus (3M ESPE); application of gingival compound resin (AmarilisGingiva, Voco, GmbH, Cuxhaven, Germany).
2. G2- Cleaning with absolute alcohol; priming with 10% hydrofluoric acid for 4 minutes; use of adhesive AdperScotchbond Multi-Purpose Plus, (3M ESPE St Paul, MN - USA); application of gingival compound resin (AmarilisGingiva, Voco, GmbH, Cuxhaven, Germany).
3. G3 - Blasting with aluminum oxide of 50 µm for 10 seconds; cleaning with absolute alcohol; priming with 10% hydrofluoric acid for 4 minutes; use of adhesive Adper Single Bond Plus (3M ESPE St Paul, MN - USA); application of gingival compound resin (AmarilisGingiva, Voco, GmbH, Cuxhaven, Germany).
4. G4 - Cleaning with absolute alcohol; priming with 10% hydrofluoric acid for 4 minutes; use of adhesive 3M ESPE Adper Single Bond, (3M ESPE St Paul, MN - USA); application of gingival compound resin (AmarilisGingiva, Voco, GmbH, Cuxhaven, Germany).



Figure 1 Porcelain tablets.

Following the surface treatment, the compound resin AmarilisGingiva, (Voco, GmbH, Cuxhaven, Germany) was inserted. In order to standardize the samples, a bipartite Teflon matrix with central hole of 5.0 mm of diameter and thickness of 3.0 mm was used. A portion of resin was placed over the central hole, and the piece was weighted on a precision scale (0.0001g) model BL 210S (Sartorius, Gottingen, Germany). Photoactivation was carried for 40 seconds with photopolymerizer EliparFree Light (3M-ESPE, Seefeld, Germany) (Figure 2). Once the specimens were manufactured, they were subjected to thermal cycling in a cycling simulator machine MSCT-3 PLUS (Marcelo Nucci-ME, São Carlos, SP, Brazil) using 5,000 cycles at 5 °C, 37,5 °C and 55 °C. Shear strength test was conducted using a universal testing machine EMIC DL2000 (EMIC, São Paulo, Brazil), with load cell of 50 KN and actuator speed of 0.5 mm per minute (Figure 3). Results were registered in Mpa. Data were organized in a spreadsheet and submitted to D'Agostino normality test followed by one-way ANOVA and Tukey's test, using the software BioEstat version 3.0.



Figure 2 Teflon matrix and test specimen.

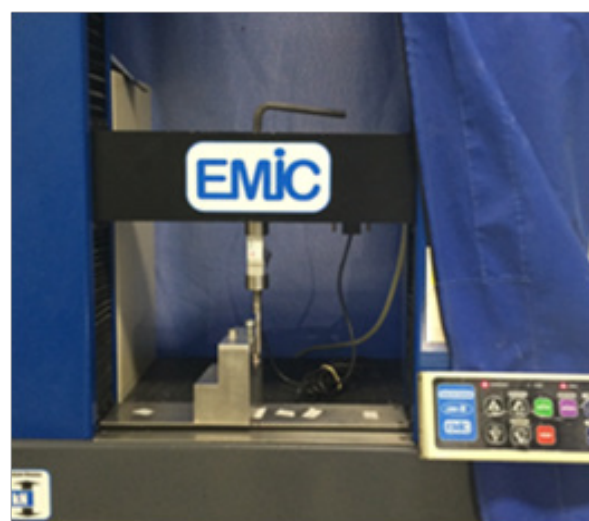


Figure 3 Shear mechanical test.

Results

Table 1 shows mean value and standard deviation of bond strength and shear strength of groups G1-G4. Two way-ANOVA showed significant interaction between surface treatments and adhesives ($p=0.003$), with test power of 84.6%. Tukey's test showed

shear strength significantly higher for ceramic surface submitted to aluminum oxide blasting, regardless of adhesive type. Among these groups, higher results were obtained with the use of adhesive 3M ESPE AdperScotchbond Multi-Purpose Plus. Among the groups not submitted to blasting, the adhesive type had no effect on bond strength (Figure 4).

Table 1 Mean and standard deviation of shear strength (in MPa) between gingival compound resin and feldspar ceramic, organized by type of surface treatment and adhesive.

Adhesive	Surface treatment	
	Blasting + hydrofluoric acid	Hydrofluoric acid
AdperScotchbond Multi-Purpose Plus	11.91 (3.,37) Aa	6.45 (3.36) Ba
Adper Single Bond Plus	7.23 (2.43) Ab	5.14 (2.46) Ba
Adhesive	Surface treatment	
	Blasting + hydrofluoric acid	Hydrofluoric acid
AdperScotchbond Multi-Purpose Plus	11.91 (3.37) Aa	6.45 (3.36) Ba
Adper Single Bond Plus	7.23 (2.43) Ab	5.14 (2.46) Ba

Caption: Mean followed by different capital letters indicates significant difference between surface treatments, considering each adhesive separately. Mean followed by small letters indicate significant difference between adhesive type, considering each surface treatment separately.

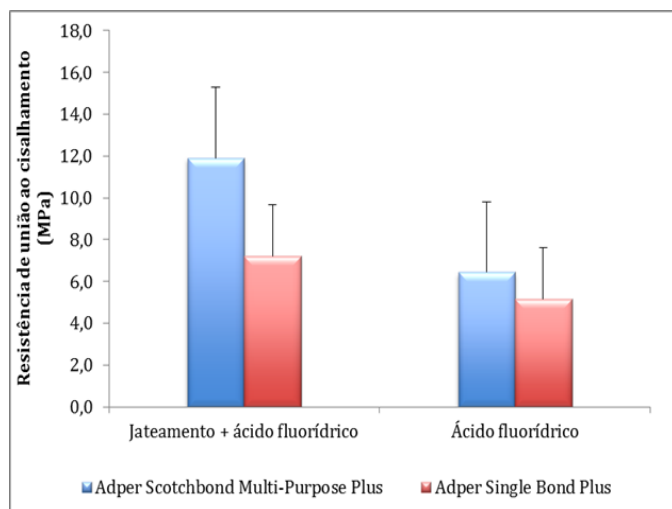


Figure 4 Bar graph showing shear strength between gingival compound resin and feldspar ceramic, according to surface treatment and adhesive.

Caption: Vertical bars represent standard deviation.

Discussion

Dental ceramics is considered an excellent material for the reproduction of natural teeth due to its aesthetical and mechanical properties. However, some clinical situations require the use of compound resin on the ceramic to restore aesthetics and function.^{3-5,10}

Techniques and methods have been proposed in the literature aiming to achieve better adherence to porcelain. According to some authors, priming of ceramic surface is key to a durable bond between the materials.¹¹ Several authors have attested the improvement in adhesion with acid surface treatment.^{6,7,12-15} According to some authors, priming with hydrofluoric acid and silane, regardless of silanization protocol used, results in no significant effect on bond strength in comparison with no silane application.⁵ Some authors report no satisfactory results when priming with hydrofluoric acid and silane are used separately.¹⁶ Berry et al.,¹⁷ on the other hand, report significant increase in bond strength of porcelain/compound resin with time of priming, and that this bond is mainly chemically induced rather than mechanically. The authors also claim that the oral environment would not reduce bond strength, in agreement with Vanderlei et al.¹⁸ According to Lacy et al.,¹⁹ bond strength between resin and porcelain is given by a combination of chemical and mechanical priming. Della Bona et al.,²⁰ added the adhesive wettability as a relevant factor to increase bond strength between ceramic and resin. The cited literature was the basis for the use of 10% hydrofluoric acid for 4 minutes in all groups in this study. In addition to the acid priming, diamond-tipped burs or blasting that create an irregular surface also yield good results for the optimization of porcelain/resin adherence by fostering the mechanical retention of resin.^{8,9} According to Shahverdi et al.,²¹ blasting of surface has a lesser effect on the bonding process in comparison with the use of burs. Here, groups treated with aluminum oxide blasting showed better shear strength results, regardless of adhesive type. In this study, preparation with blasting and priming with hydrofluoric acid resulted in higher shear strength between compound resin and feldspar ceramic. This is in agreement with Shiu et al.¹¹ and Phoenix

& Shen,²² that claim that mechanical and chemical treatment of the feldspar porcelain surface produce an increase in surface area and surface energy, leading to a change in topography, which, in turn, is responsible for the increase in bond strength. The use of the adhesive 3M ESPE AdperScotchbond Multi-Purpose Plus (11.91MPa) along with the treatment of the ceramic surface with aluminum oxide blasting resulted in significant improvement of the bond between compound resin and ceramic in comparison with the group using the adhesive 3M ESPE Adper Single Bond Plus (7.23MPa). On the other hand, this difference was not observed between the groups without treatment with aluminum oxide blasting. This is in agreement with authors that advocate for the association of surface treatment and adhesive agents for better results.²³ Further studies might contribute with relevant information on this issue and provide recommendations on safe and effective materials and methods.

Conclusion

According to this study, it is possible to conclude that:

The ceramic surface submitted to aluminum oxide 50µm blasting followed by cleaning with alcohol and priming with hydrofluoric acid at 10% showed significantly higher shear strength, regardless of adhesive type; Between the groups submitted to blasting, the use of 3M ESPE AdperScotchbond Multi-Purpose Plus showed better results in comparison with 3M ESPE Adper Single Bond Plus; Without blasting, the type of adhesive showed no influence on bond strength results.

Acknowledgments

None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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