Effect of the addition of propolis on a soft denture liner on bond strength with an acrylic resin

Efeito da adição de própolis em um reembasador resiliente de prótese na resistência de união com resina acrílica

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Abstract

Objective – To evaluate the effect on bond strength of an acrylic resin and thermoatived resilient denture liner material with different concentrations of propolis. **Methods** – Fourty eight specimens of acrylic resin (Lucitone 550, Dentsply) were made and united with the soft liner (Coe Soft, GC America) with different concentrations of propolis: group 1 (control) – only Coe Soft; Group 2 – Coe Soft + 75 mg of propolis; Group 3 – Coe Soft + 150 mg of propolis, and Group 4 – Coe Soft + 300 mg of propolis. The union traction resistance test was performed, and the type of fracture was evaluated. The data were analyzed descriptively and by one-way ANOVA, followed by Tukey's test (p=0.05). **Results** – There was no difference between the control group and when 75 mg of propolis was added (p>0.05), while the group with 150 mg of propolis showed lower bond strength (p<0.05), However, group 4 did not differ from the others (p>0.05). Regarding the kind of fails, the control group and group 2 showed the same failures: 91.7% cohesive and 8.3% adhesive. Group 3 showed only cohesive failure, and group 4 had cohesive failures (58.4%), adhesive (8.3%) and mixed (33.3%). **Conclusions** – It can be concluded that 75 mg of propolis extract may be considered the most suitable concentration to be added in the soft denture liner, considering that the properties of soft denture liner was not changed.

Descriptors: Propolis; Dental prosthesis; Denture liners

Resumo

Objetivo – Avaliar o efeito na resistência de união entre resina acrílica e reembasador resiliente de prótese termoativado com diferentes concentrações de própolis. **Métodos** – Quarenta e oito espécimes de resina acrílica (Lucitone 550, Dentsply) foram confeccionados e unidos ao reembasador resiliente (Coe Soft, GC América) com diferentes concentrações de própolis: Grupo 1 (controle) – apenas o Coe Soft, Grupo 2 – Coe Soft + 75 mg de própolis; Grupo 3 – Coe Soft + 150 de própolis e Grupo 4 – Coe Soft + 300 mg de própolis. Foi realizado o teste de resistência à tração e o tipo de fratura foi avaliado. Os dados foram analisados de forma descritiva e através de análise de variância a um critério, seguido pelo teste de Tukey (p=0,05). **Resultado** – Não houve diferença entre o grupo controle e quando 75 mg de própolis foi adicionao (p>0,05), enquanto o grupo com 150 mg de própolis mostrou menor resistência de união (p<0,05). No entanto, o grupo 4 não diferiu dos demais (p>0,05). Em relação ao tipo de falha, o grupo controle e o grupo 2 apresentaram as mesmas falhas: 91,7% coesivas e 8,3% adesivas. O grupo 3 obteve apenas falha coesiva, e o grupo 4 teve falhas coesivas (58,4%), adesivas (8,3%) e mistas (33,3%). **Conclusões** – Conclui-se que 75mg de extrato de própolis pode ser considerada a concentração mais adequada para ser adicionada ao reembasador de prótese, considerando-se que as propriedades deste reembasador resiliente de prótese não foram alteradas.

Descritores: Própolis; Prótese dentária; Reembasadores de dentadura

Introduction

There are still many patients who make use of removable dentures, which are made of acrylic resin material with good properties, such as: acceptable esthetics, strength, low cost and ease of handling. However, this material is rigid and can cause injury to oral tissues and adjustments are necessary to improve the fitness of the prosthesis[1-2]. One solution to this problem is the use of resilient denture liners materials that possess viscous elastic properties and have the capacity to absorb the impact energy of masticatory forces and distribute them evenly over the supporting tissues, giving more comfort to the patient[3].

The ideal properties of resilient denture liners are: to be easy to handle, have minimal dimensional change, having minimal water absorption, maintain resilience in clinical use, be easy to clean, does not change color nor tarnish, not toxic, be tasteless and odorless, exhibit acceptable aesthetics, have minimal solubility in water having a thickness of 2 to 3 mm, should not be colonized by bacteria or fungi, non-irritating, do not deteriorate and mostly have a high bond strength to denture base[4].

Disruption of this bond leads to the formation of an area of difficult cleaning and proliferation of fungi and bacteria, being *Candida albicans* the most common fungus[5-6]. In 2009, Ferreira *et al*.[7] showed that enzymatic cleansers are not effective in disinfecting liners, and adding the chlorhexidine materials affects the polymer chain to promote deleterious effects on the mechanical properties of the resins, due to interruption of the physical form of the polymer.

The effectiveness of propolis in dentistry has been proven in various areas, demonstrating it's anti-inflammatory, antibacterial, antifungal, healing action, hae-

mostatic, positive action for tissue reorganization superficial level and demineralization / remineralization of tooth enamel[8-9].

In this context, this study evaluated the effect on bond strength of an acrylic resin and thermoatived resilient denture liner material with different concentrations of propolis. Our hypothesis is that there will have no difference in bond strength between acrylic resin and soft liner material regardless the different concentration of propolis used.

Methods

Experimental design

This in vitro study had a randomized and blinded design. The bond strength between acrylic resin and denture liner was analysed when different amont of propolis were added in the liner (75mg, 150mg or 300mg). Soft liner without propolis was used as control. The patter of failure (cohesive, adhesive or mixed) was also evaluated. Data were analyzed descriptively and by one-way ANOVA followed by Tukey's test at 5% significance level.

Fabrication of specimens

It were made 48 specimens measuring 5x8x3 mm united in pairs by the end of 5 mm heat polymerizable acrylic resin (Lucitone 550, Dentsply) and through the soft denture liner (Coe Soft, GC America), to which was added propolis extract in different concentrations were prepared forming 4 groups (n=12), as demonstrated on Table 1.

Table 1. Experimental groups under the addition of propolis

Group 1	A portion (4 g of powder and 4 ml of liquid) of Coe-soft denture liner.
Group 2	Two portion (8 g of powder and 8 ml liquid) of Coe-soft denture liner, with addition of 01 capsules of 150 mg dry extract of pure propolis. Amount of propolis 75 mg per serving.
Group 3	A portion (4 g of powder and 4 ml of liquid) Strain of soft denture liner, with the addition of 150 mg propolis. Amount of propolis per serving is 150 mg.
Group 4	A portion (4 g powder and 4 ml liquid) Strain of soft denture liner, with the addition of 02 capsules of 150 mg each of propolis. Amount of propolis per serving is 300 mg

A metallic muffle with specific dimensions was developed for this study. It consisted of 5 overlapping metal plates in the following order: a lower base that is stabilized and others, that has two lateral bars and two screws that pierce the following allowing juxtaposing them all and closing the furnace through screw.

Superimposed on the base plate, metal plate with removable spacer bars, the base sequence followed by another plate with spacer bars, and to close, which serves as cover. For standardizing the places where the soft denture liner was inserted, the muffle had six metal spacer bars with 3mm of thickness, these were interposed in the spaces for the insertion of the denture liner material, providing and standardizing the space of 3 mm, this thickness being considered ideal for clinical use[10]. The acrylic resin Lucitone 199 was manipulated according to the manufacturer's guidelines, and then inserted into the spaces formed by the overlap of the intermediate (and their spacer bars) and lower plates. The muffle was closed and taken hydraulic bench press (Techno, Vineyard, São Paulo, Brazil), and subjected to a pressure of 1.25 tons per 10 minutes. All plates were isolated on their surfaces with Vaseline solid (Vaseline solid – Quimidrol Chemical Industry, São José do Rio Preto, São Paulo, Brazil). After pressing, the muffle was opened and its separate parts removed excess resin, the plates were again isolated, the muffle closed and taken press at 1.25 ton for 30 minutes. Soon after it was taken to heat polymerized (Termotron, São Paulo, Brazil), for the completion of the polymerization cycle. After completion of the curing cycle and cooling, the muffle was opened and the bodies of deflasked proof, and subsequently passed through the finishing process, using a flat polishing (Arotec, São Paulo, Brazil). In each presage, 48 samples of acrylic resin, yielding 24 specimens were obtained (Figure 1).

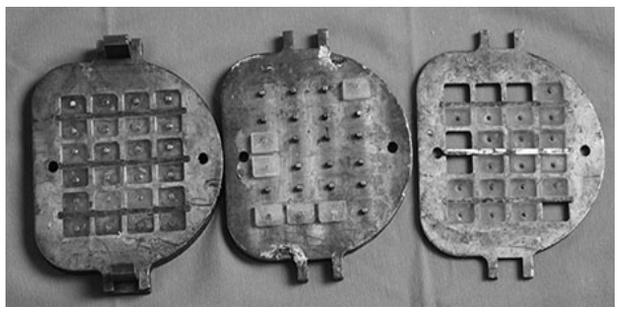


Figure 1. Acrylic resin specimens

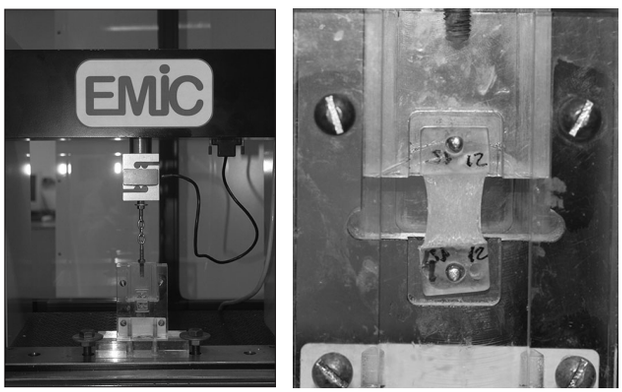
Samples of acrylic resin were repositioned in the source muffle plates, but without the spacer bars. This space was filled with soft denture liner plus or absence of different concentrations of propolis. The soft denture liner was manipulated according to the manufacturer's guidelines, each portion corresponding to 4g of powder to 4ml of liquid. The propolis were obtained at pharmacy manipulation (Eficácia – Pharmacy Manipulation, Itajaí, SC, Brasil) with the amount already heavy in each capsule of 150 mg of pure dry extract, and transformed into powder. At group 1 – control, were used only denture liner, at second group, the denture liner was increased by 75 mg of propolis, at the third group, the increased was 150 mg and at the fourth was 300 mg of propolis. After the prepare of the denture liner, this material was poured into the spaces between acrylic resin samples until overflow of the material occurs. The muffle was closed and taken to the hydraulic bench press, being subjected to pressure of 1.25 tones, after 10 minutes it was open and the bodies of deflasked proof (Figure 2).

Figure 2. Final specimens in the muffle

Response variable

The response variable was the bond strength measured in MPa, and the type of fracture occurred, measured qualitatively, if adhesive, cohesive or mixed.

The specimens were taken to a universal testing machine (EMIC DL-200, Pinhais, Paraná, Brazil), and then positioned so that the samples remain perpendicular to the horizontal plane and form traction until rupture occurs. A load of 50 kgf and a constant speed of 5mm/min were applied (Figures 3 and 4).



Figures 3 e 4. Universal testing machine, with the specimen positioned. Specimen positioned during the test.

The rupture was analyzed visually and classified as follows: cohesive (where rupture occurs within the denture liner materials), adhesive (when the breakage occurs between the denture liner materials and acrylic resin) and mixed (when it occurs inside the reliner and between it and the resin acrylic).

Statistical analysis

The statistical analysis was carried out using the SAS/LAB software package (SAS Software, version 9.0; Cary, NC, USA) with the significance level of 5%. The normality of error distribution and the degree of non-constant variance were checked for the response variable. All data were analyzed by one-way ANOVA, considering the amount of propolis extract added as study factor, and the bond strenth as response variable. Tukey's HSD test was used for post-ANOVA comparisons.

Results

Regarding the patter of failures, it was found predominatly cohesive failures (Figure 5), regardless of the amount of propolis extract added, which totaled 91.7% of ruptures in the control group or that in which was added 75mg propolis extract; 100% on the condition that it was used 150mg, and 58.4% when it was used 300mg of the substance. As a result of adding 300mg of extract of propolis, mixed failure was 33.3% in the samples. Have breaks the adhesive type occurred in a proportion of 8.3% of the specimens in the control group and those in which there was the addition of 75 or 300mg of propolis extract (Table 2).

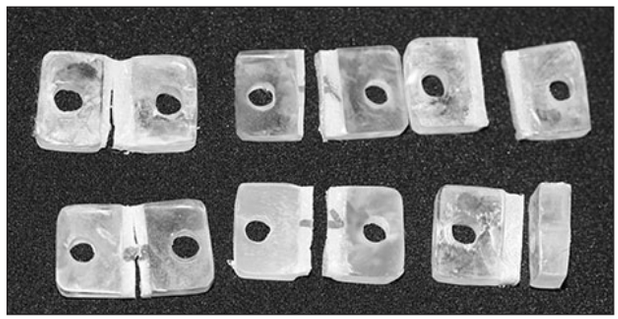


Figure 5. Specimens with predominatly cohesive failures

Table 2. Failure modes observed between thermoatived acrylic resin and resilient denture liner material added different amounts of propolis

	Cohesive	Adhesive	Mixed
Control	91.7	8.3	0
Propolis (75 mg)	91.7	8.3	0
Propolis (150 mg)	100.0	0	0
Propolis (300 mg)	58.4	8.3	33.3

In relation to the bond strength between e acrylic resin and thermoatived resilient denture liner material in the different conditions, the one-way ANOVA demonstrated that there was significant difference between the groups regarding the values of bond strength by pull between the acrylic resin and denture liner material added thermoatived of propolis extract in different amounts ($p<0.0001$). The Tukey test showed that significantly higher values of union resistance were observed in the control group and the experimental group that received 75mg of propolis added to Coe Soft, compared to that in which there were 150mg. In the 300mg group, intermediate values of bond strength were found, which did not differ from all groups (Table 3).

Table 3. Values of bond strength, tensile strength (MPa), between the acrylic resin and thermoatived resilient denture liner material added different amounts of propolis extract

Group	Bond strength
Control	0.11 ± 0.02 A
Propolis (75 mg)	0.11 ± 0.02 A
Propolis (150 mg)	0.08 ± 0.01 B
Propolis (300 mg)	0.10 ± 0.01 AB

Distinct upper case letters indicate statistically differences among the groups.

Discussion

This study evaluated the effect on bond strength of an acrylic resin and thermoatived resilient denture liner material with different concentrations of propolis. In the present study, it was studied the addition of pure propolis powder, to take advantage of its therapeutic properties, directly to the denture liner material, as well as its influence on the outcome of accession with the same acrylic resin, and the effect of their addition at different concentrations.

It should be pointed that the relining materials based on acrylic resin have excellent adhesion to acrylic resins, however, the breakup of the union of denture liner and acrylic resin leads to the formation of areas of difficult hygiene and may lead to proliferation of fungi and bacteria[4,11]. This proliferation may compromise the longevity of the prosthesis, and increase the surface roughness, resulting in high risk of bacterial adhesion and oral infections[12].

In 2013, Kang *et al*.[13] showed that the degree of hydrophobicity and hydrophilicity has greater influence on bacterial adhesion in relation to the surface roughness. The addition of agents such as nystatin, miconazole, chlorhexidine and fluconazole do not affect the surface roughness and hardness of the materials and also inhibit the growth of Candida albicans, but does have other pharmacological properties among them, i.e. healing activity, anesthetic, haemostatic, anticariogenic, anti-inflammatory, antibiotic such as propolis[13-14]. Additionally, propolis does not cause any citotoxicity effect on the human organism[8]. In this context, propolis extract was studied here added to reliner material in different concentrations to take advantage of their pharmacological properties.

The knowledge about how would be the best concentration of propolis to be added in the reliner material is necessary, in order to maintain the features of liner and do not interfir on bond strength to acrylic resin. So, the tensile test is the most appropriate to provide information about the adhesion between denture liner and acrylic resin[15]. The assay was performed using a universal testing machine with traction speed of 5 mm/min. The literature demonstrates several methods for this study, including differences in the speed test[3,15-17], although the speed of 5mm/min was chosen considering have the greater chance of absorbing the stresses denture liner material before the onset of failure, allowing elastic deformation and plastic were to fracture occurrence. When the specimens were driven at higher speeds, tensions manifest themselves very quickly and concentrate inside the denture liner material rather than being propagated to the interface region[17]. In this way, the values would be related to the tensile strength of the liners, not from among the reline and acrylic resin. However, laboratory tests can only apply one type of force which does not occurs with the chewing that the prostheses are subjected clinically forces[15].

The rupture of the adhesion between denture liner materials and the denture base is one of the most commonly occurring problems[18]. The water acts as liners adhesion between the base material and the prosthesis such that the properties of resilient material are changed thereby decreasing the adhesion values, occurring interface plasticizer loss and the consequent increase of rigidity stiffness over time[19]. Due to this fact, in this study, propolis was manipulated in its solid state and used in the form of powder, so that there was no liquid medium interfering with adhesion of materials.

In the present study, the tensite bond strength between control group and when 75mg of propolis was added did not differ, although 150mg added resulted in lower bond strength. Interstingly, 300mg of propolis added did not differ from any of the results found. The hypothesis would be that the denture liner has a different molecular structure than propolis. These structures can become sticky and with considerably reduced stiffness in the presence of propolis[20]. In this case, there is no interaction between the molecular reliner and propolis, and probably the union between acrylic resin and relining depends on the diffusion and penetration of the monomer in the structure of the base resin[20]. Thus, it is possibly that with the increase amount of propolis, the amount of area decreased by denture liner. Another interesting fact is that the release of waste turns the reliner more rigid, reducing its elasticity and its resilience, reducing its effectiveness as a soft denture liner[19]. In fact, the clinical consideration that should be highlighted is that the modulus of elasticity of these materials should be similar to oral tissue surrounding them because they tend to absorb the occlusal forces through resiliency.

Based on the types of disruptions, a hypothesis for the finds in this study is that the addition of 75mg of propolis was a small amount and did not cause changes in the physical properties of denture liner material. The addition of a larger amount (150mg) changed the physical/chemical properties and modulus of elasticity of reliner, justifying the occurrence of purely cohesive failures. In the group of 300mg, in which the proportion of propolis increased by 4 times compared to group 2, there was another kind of change in the physical properties, decreasing the number and effectiveness of cross linking of the polymer and its adhesive properties, resulting in mixed type (33.3%), cohesive (58.4%) and adhesive (8.3%) failures. The cohesive type failures happened within the denture liner material, and predominated in all groups, probably because of the resilient denture liners and the denture base having similar chemical components, thus forming a network of molecules ranging entwining the joint surfaces[21]. In addition, adhesive failures occur between the denture liner materials and acrylic resin in 3 groups (control, 0,75 mg and 300 mg of propolis added), always with the same rate of 8.3%, indicating that propolis has not diminished the adhesion of the acrylic resin denture liner, since the percentage of adhesive failures was the same as the control group.

It should be noted that this study did not evaluate whether propolis added after the soft denture liner re-

tained its pharmacological properties and for how long, and whether the doses used here were sufficient to have antimicrobial activity. Although the pharmacological properties of propolis, the surface roughness is a factor to be considered in contamination by fungi and bacteria, this experiment tests were performed to check for any changes in the surface of the denture liner and the effects on bacterial proliferation. Based on these evidences, we suggest the development of most laboratory and clinical studies regarding the adhesion of the lining materials plus pure propolis powder, and the effectiveness and efficiency of their pharmacological properties.

Conclusion

Within the limitations of this study, it can be concluded that 75 mg of propolis extract may be considered the most suitable concentration to be added in the soft denture liner, considering that the properties of soft denture liner was not changed.

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