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The Adhesion of Modern Soft Relining Materials to Acrylic Dentures*

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article; **G** – other

Abstract

Background. Silicone-based liners are widespread materials in prosthetic dentistry. Their mechanical properties have to meet several key requirements such as adequate adhesion to denture base polymers in order to provide right function of masticatory system and oral hygiene.
Objectives. The aim of this paper was to evaluate and compare tensile and shear bond strengths values of three modern autopolimeryzed silicone relining materials bonded to acrylic plates.
Material and Methods. Three silicone-based soft relining materials were investigated in this study (A-Soft Line 30, Bosworth Dentusil and Elite Super Soft). A total of 78 specimens were prepared: 13 of each material (total: 39) for testing tensile bond strength and 13 of each material for testing shear bond strength (total: 39). The obtained data were analyzed statistically.
Results. The average tensile bond strength results were 0.86 MPa for Bosworth Dentusil, 1.00 MPa for Elite Super Soft and 1.25 MPa for A-Soft Line 30. The silicone-based relining materials had different average values of shear bond strength: 0.67 MPa Elite Super Soft; 1.32 MPa A-Soft Line 30 and 1.57 MPa Bosworth Dentusil.
Conclusions. As the result of the study it can be concluded that all tested materials have acceptable adhesion values to acrylic resin. According to tensile and shear bond strengths tests the best adhesive properties has A-Soft Line 30 (**Adv Clin Exp Med 2014, 23, 4, 621–625**).

Key words: soft relining materials, silicone elastomers, adhesion, acrylic dentures.

Soft lining materials play a major role in prosthetic dentistry. The viscoelastic properties of denture liners reduce and redistribute the functional load over the denture-bearing area. The indications for denture lining are mucosal discomfort and chronic soreness that may be caused by bony irregularities, occlusal problems and reduced keratinization of the epithelium. Soft liners are also used for obturators after maxillofacial surgery or to increase retention in cases of bilateral undercuts [1, 2]. In addition to viscoelasticity, there are several other requirements for soft liners, including high dimensional stability, color stability, tear resistance, biocompatibility with oral tissue and good adhesion to the denture base [3–9].

There are two types of commercial soft liners: those based on acrylic resin and those based on silicone elastomers [10]. In the oral cavity environment, silicone liners are more resistant to distortion, hardening and debonding from the denture base than acrylic liners [11–13]. However, the most common reason for the failure of silicone elastomers under clinical conditions is a loss of adhesion to acrylic resin. It is therefore crucial to in-

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vestigate the adhesive properties of silicone lining materials.

The purpose of this paper was to judge the adhesion of three modern silicone lining materials to denture base polymers. Their tensile bond strength and shear bond strength were measured 24 hours after the preparation of specimens.

Material and Methods

Three silicone-based soft lining materials were investigated in this study (Table 1). A total of 78 specimens were prepared: 13 of each material for testing tensile bond strength (total: 39) and 13 of each material for testing shear bond strength (total: 39).

The specimens for the tensile bond strength test had two parts: acrylic and silicone, both cylindrical in shape (20 mm long; 4 mm in diameter), which were bonded to each other by the adhesive agent recommended by the manufacturer of the silicone material. The specimens for shear bond strength test also consisted of two parts: a silicone cylinder (5 mm long; 4 mm in diameter), bonded centrally by their base to a rectangular acrylic plate (20 mm long; 10 mm wide) using the adhesive agent recommended by the manufacturer of the silicone material. All the materials were processed according to the manufacturers' instructions and were stored in distilled water at room temperature for 24 h before testing.

Both the tensile bond strength tests and shear bond strength tests of the adhesion of the silicone-based lining materials to acrylic resin were carried out in a Hounsfield H5KS universal testing machine (Tinius Olsen, Salfords, England; model HTE S/N D83281) at a crosshead speed of 5.0 mm/ /min until the specimen failed.

The descriptive data are presented as mean values. The results were analyzed with a two-way analysis of variance (ANOVA). The *post hoc* Fisher test (NIR) was also used to compare the adhesion of the relining materials to the denture base polymer. Statistical significance was set at $p \leq 0.05$. An analysis of the distribution of the volatility measurements in the three groups using the Shapiro-Wilk test showed that they are no dfifferent from normal distribution. Levene's test was used to assess the homogeneity of the variance measurements; it showed that there are no grounds for regarding the variance in the three groups as heterogeneous. All the statistical analyses were done using STATISTICA Version 10 software (Statsoft Inc., Tulsa, Oklahoma, USA).

Results

The tensile bond strength in MPa of the tested materials was calculated by dividing the load (uniaxial tension) by the specimen's acrylic-silicone adhesive area. The shear bond strength was calculated the same way. Tensile and shear bond strength tests result for each sample and the average values are shown in Table 2 and Table 3, respectively.

The average tensile bond strength results were 0.86 MPa for Bosworth Dentusil, 1.00 MPa for Elite Super Soft and 1.25 MPa for A-Soft Line 30. The two-way ANOVA analysis showed significant differences between those values [F: (2.36) = 4.18; p = 0.02]. The *post hoc* Fisher analysis showed that the tensile bond strength of A-Soft Line 30 is significantly higher than Bosworth Dentusil (p = 0.008). The average values of A-Soft Line 30 and Elite Super Soft did not differ significantly. There is also no significant difference between Elite Super Soft and Bosworth Dentusil. The results of a comparison of the mean values for tensile bond strength are presented graphically in Fig. 1.

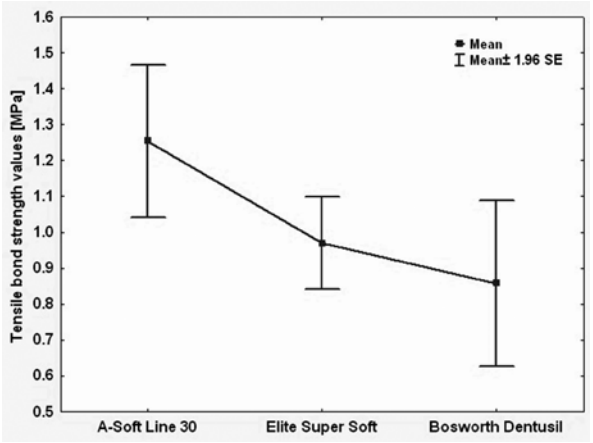

Fig. 1. Comparison of tensile bond strength mean values for the tested relining materials

Table 1. Materials used in the study

Material	Lot number	Manufacturer
A-Soft Line 30	6505853	S&C Polimer GmbH, Elmshorn, Germany
Bosworth Dentusil	0609PR759	Bosworth Company, Skokie, Illinois, USA
Elite Super Soft	C700110	Zhermack, Badia Polesine, Italy

Table 2. Tensile bond strength values of soft relining materials

Material Specimen no.	A-Soft Line 30 (MPa)	Elite Super Soft (MPa)	Bosworth Dentusil (MPa)
1.	0.96	0.76	1.43
2.	0.93	1.19	0.77
3.	1.93	1.00	0.12
4.	1.55	0.65	0.91
5.	0.74	1.23	1.43
6.	1.48	1.44	1.47
7.	1.10	1.13	0.52
8.	1.69	1.08	0.75
9.	1.40	0.87	0.44
10.	0.74	0.97	1.01
11.	1.48	0.78	0.71
12.	1.48	0.68	1.14
13.	0.83	0.83	0.45
Mean values (SD)	1.25 (0.39)	1.00 (0.24)	0.86 (0.42)

Table 3. Shear bond strength values of soft relining materials

Material Specimen no.	A-Soft Line 30 (MPa)	Elite Super Soft (MPa)	Bosworth Dentusil (MPa)
1.	1.58	0.76	1.11
2.	1.55	0.54	1.10
3.	1.10	0.72	1.28
4.	1.50	0.50	2.01
5.	1.58	0.63	1.01
6.	1.44	0.65	1.52
7.	1.63	0.28	1.39
8.	1.32	1.00	1.71
9.	1.03	0.54	1.73
10.	0.98	0.83	1.54
11.	1.13	0.72	1.62
12.	1.05	0.67	1.33
13.	1.32	0.85	1.52
Mean values (SD)	1.32 (0.24)	0.67 (0.18)	1.57 (0.29)

The silicone-based relining materials had different average values of shear bond strength: 0.67 MPa Elite Super Soft; 1.32 MPa A-Soft Line 30 and 1.57 MPa Bosworth Dentusil. The ANOVA analysis showed that the average shear bond strength of the tested relining materials differ significantly [F: (2.36) = 39.91; $p < 0.0001$]. According to the *post hoc* Fisher analysis, the average value for Elite Super Soft was significantly lower than the average values for A-Soft Line 30 and Bosworth Dentusil ($p < 0.0001$). It was also confirmed that there is no significant difference in shear bond strength

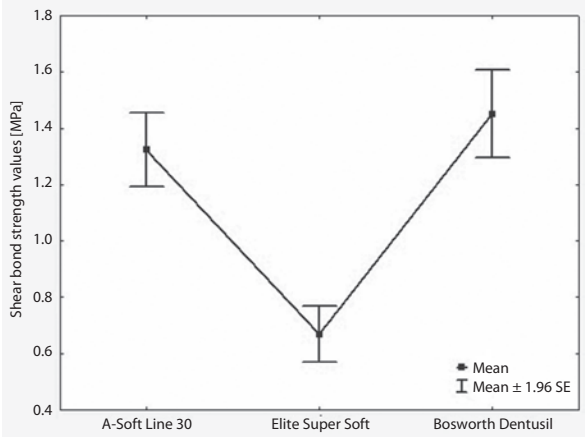

Fig. 2. Comparison of shear bond strength mean values for the tested relining materials

values between A-Soft Line 30 and Bosworth Dentusil. A graphic presentation of a comparison of the mean values for shear bond strength is presented in Fig. 2.

Discussion

The mechanical properties of relining materials have an influence on their usage. A crucial issue is the quality of adhesion of soft lining materials to denture base polymers, which can be evaluated by testing tensile bond strength and shear bond strength [14–16]. During use or brushing the denture surface, tensile and shear loading may lead to separation of the liner from the denture base. As a result, the denture becomes unhygienic and nonfunctional [17]. Besides direct mechanical forces, the adhesion of silicone liners can be reduced by temperature, the oral environment or solutions used for cleaning dentures [14, 18, 19]. In this study, tensile bond strength and shear bond strength were measured after a 24-h storage period in distilled water, which, according to research by Al-Athel et al., does not change the values of primary adhesion [18].

Kawano et al. claimed that the lowest tensile bond strength value should be 0.96 MPa [20]. Comparing the tensile bond strengths of the three silicone liners in the current study to this minimally acceptable value, only Bosworth Dentusil did not have the proper bond strength. Under clinical conditions, shear bond strength is more critical than tensile bond strength, as the distribution of functional forces includes mostly shear loading. The A-Soft Line 30 and Bosworth Dentusil silicone liners had greater shear bond strength than tensile bond strength, which is a clinically positive prognostic factor. In contrast, the Elite Super Soft liner has lower shear bond strength than tensile bond strength, which agrees with the results of Elias et al. [14].

The present study concentrated on autopolymerized silicone lining materials, as these are the most frequently used liners because of their mechanical properties and easy usage. It is important to note that there is still no perfect soft lining material that meets all the key requirements. The adhesive and other mechanical properties of commercialy available silicone liners should be regulary checked in order to assure the best quality of function and hygiene of relined dentures.

The following conclusions can be drawn:

1. All three of the tested silicone relining materials gave satisfactory results and can be recommended for clinical use.
2. A-Soft Line 30 has the best average tensile bond strength of the three silicone relining materials investigated.
3. Bosworth Dentusil has the best average shear bond strength of the three silicone relining materials investigated.
4. According to the tensile bond strength and shear bond strength tests carried out, A-Soft Line 30 has the best adhesive properties.

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