Structure and the Shear Bond Strength of Two Pit and Fissure Sealants

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Resin-based pit and fissure sealant materials are heterogeneous materials with two principal components: the resin matrix and the filler particles. The shear bond strength test holds great importance for providing insight into the adhesion of these materials and, also, it is a screening mechanism for predicting clinical performance. The purposes of the present study are to investigate the structure of surface and the shear bond strength for two commercial pit and fissure sealants, Fissurit (VOCO) and Pit & Fissure (DMP) sealer. Seal Fissurit had the highest shear strength, and the difference was statistically significant between two tested materials.

Keywords: Resin-based pit and fissure sealant, structure of surface, shear bond strength

Sealant materials were developed in the 1960s and have been used widely since then.

Resin composites are used for a variety of applications in dentistry including but not limited to restorative materials, cavity liners, pit and fissure sealants, cores and buildups, inlays, onlays, crowns, provisional restorations, cements for single or multiple tooth prostheses and orthodontic devices, endodontic sealers, and root canal posts [1].

In the present study, the purpose is to investigate the structure of surface and the shear bond strength for two commercial pit and fissure sealants, Fissurit (VOCO) and Pit & Fissure (DMP) sealer. The obtained data were statistically processed with the Anova test. The mean values of the two sealing materials were compared. The p threshold of significance was 0.05.

The present in vitro study was conducted on 20 carries free surfaces of premolars, extracted for orthodontic purposes. On either side of the proximal surface, the teeth selected were cleaned with hand scalers to remove necrotic tissue, blood debris, stains and calculus. They were then washed with a toothbrush under running tap water. The mesial or distal surfaces were cleaned. The samples selected were cleaned with hand scalers to remove necrotic tissue, blood debris, stains and calculus. They were then washed with a toothbrush under running tap water. The samples were then stored in artificial saliva [4].

Teeth were randomly divided into two groups: group 1 and group 2, each having 10 samples of teeth. In group 1, the Fissurit FX (Voco) sealant was used and in group 2, the Pit & Fissure Sealant (DMP) sealant was used. The surface of the enamel was planned and finished using a 600 grain abrasive paper. After being grouped and cleaned, the enamel surfaces of each tooth were etched for 30 s with 37% phosphoric acid and then washed with water, 15 s. After drying each specimen for 30 s, the sealant was applied on the enamel surfaces (3mm in diameter and 4mm in length), and was light cured for three s intervals, one from the top and two from the sides. Recordings were made after 10 min from sealing the enamel and after a month from sealing the enamel.

The obtained data were statistically processed with the Anova test. The mean values of the two sealing materials were compared. The p threshold of significance was 0.05. The materials used in this study are presented in table 1. In order to determine the morphology of the obtained powders and in order to investigate the surfaces of the samples subjected to the solubility test, before and after

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Experimental part

Materials and methods

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testing, an INSPECT S (FEI Co) microscope was used. As the electronic microscope is a magnifying device that can be used for the morphological examination of tissues, of contours and geometrical forms of microparticles, its applicability and relevance to the present study are unquestionable.

For obtaining the samples, in order to determine the shear forces, a steel circle has been filled with PMMA, and the root of the premolars has been inserted to the point of the enamel-cement junction. The mobile part, made out of teflon, had a square hole in the middle, with a 3mm side and a 4 mm depth. This part is intimately adapted to the prepared surface of the tooth, the hole being centered on the prepared surface. Then, the hole is filled with the sealing material. In this matrix, the sealing material in applied in 2mm layers, successively light cured. After polymerase, the sample is detached from the matrix and is kept in the artificial saliva until the testing moment. The shear forces were registered with the help of a universal testing apparatus LOYD - Soft Nexygen for mechanical testing, using a speed of 0.5mm/min.

The retention force $S$ [MPa] of the tested sealing material was calculated by dividing the cadence force $F$ (N) to the surface $A$ (mm$^2$) of the sealing segment: $S=F/A$.

**Results and discussions**

Scanning electron microscopy (SEM): In figure 2, images of the structure surface of the dental enamel sealed with the Fissurit material, magnified x 1000(a), x1500(b) and also the structure of the Fissurit sealant surface magnified x10000(c), can be visualised. The sealing material presents a surface with inorganic particles (under 2 µm) and also agglomerations of these particles, of smaller dimensions. Also, opalescent particles are present. A uniform distribution of the inorganic filling in the organic matrix can also be observed.

In figure 3, the structure images of the dental enamel sealed with the Pit and Fissure sealant magnified x 1000(a) and also the structure of the Pit and Fissure sealant surface magnified x10000(b), can be visualised.

The acid etching process of the enamel surfaces of the teeth has an important role in the adhesion of the sealant, as it creates microscopic retentions (microscopic fissures) in which the sealant to penetrate.

If the utilized sealing material has a uniform composition and a fine inorganic composition, it will manage to penetrate much easier the microscopic fissures created on the surface of the enamel, throughout the acid etching process, thus enhancing a adequate adhesion [6].

Resin-based pit and fissure sealant materials, such as Fissurit FX are heterogeneous materials with two principal components: the resin matrix and the filler particles [7].

The shear bond strength test holds great importance for providing insight into the adhesion of these materials. Also it is a screening mechanism for predicting clinical performance [8, 9].

The shear bond strength depends on the many factors such as: composition of the resin matrix, viscosity of the resin-based materials, the size of the filler particles, and type of filler material [10].
The major limitation is related to microleakage. Dental materials, currently used, have limitations, and one always has to take into account that fissure sealants and other materials, which contain fluoride in their composition. Sealing ability and shapes of fillers, since both materials are resin-based and have non-ideal mechanical behaviour.

The shear resistance of the adhesion was generally utilised in order to evaluate the adhesive systems in vitro. Studies to determine the performances of different systems and techniques are important, especially for the relative values obtained, but numerical comparisons are not always possible. By consulting other similar studies, we find that there is a great variability of the shear strength results, according to the utilised method. So, the different values of the MPa are not compared between authors, but rather it is preferred to explore the trends in studied material behaviour.

Meerbeek and al [11], show that the fundamental principle of adhesion to tooth substrate is based upon an exchange process by which inorganic tooth material is exchanged for synthetic resin. They affirm that this process involves two phases: removing calcium phosphates by which microporosities are exposed at the enamel and the infiltration and subsequent in situ polymerization of resin within the created surface microporosities. There is an additional chemical interaction between functional monomers and tooth substrate components [11]. The mechanical stresses tend to concentrate on the angles and protuberances of the particles [12]. The Pit & Fissure sealers are considered larger fillers than the Fissurit FX. The main difference between the tested sealants relies on the presence of fillers amounts and shapes of fillers, since both materials are resin-based and contain fluoride in their composition. Sealing ability and shear bond strength differs among different fissure sealants used [13]. Probably higher value for shear strength increases the longevity of sealant.

After Jumanca et al [14], health professionals should always take into account that fissure sealants and other dental materials, currently used, have limitations, and one major limitation is related to microleakage.

In the researches of Saveanu et al [15], it is underlined that most of the differences statistically significant were obtained by analyzing color criterion, generally diacrylic hybrid composite resin with ceramic particles showing the best scores.

### Conclusions

Seal Fissurit had the highest shear strength, and the difference was statistically significant between two tested materials. Most filler particles of both the pit and fissure sealants are of irregular shape. An optimal resin composite should mimic structural, physical and mechanical characteristics of dentin and enamel.

### References