Evaluation of Impact of Technological Factors on Dental Composites

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Dental composites, some of the most used materials in the last decade, have been and still are the focus of the researches in the last period of time. The present study aims to evaluate three of the most used composites given their different behaviour in practice. There were performed: the flexural strength test, the compression strength and resistance test at diametral compression according to ADA Sp.27/1993 specification. The results were surprising given the differences between the values obtained for the samples of each material. The study concludes that the variable properties of the composites in the same conditions originate from their inconstant microscopic structure.

Keywords:dental composites, flexural strength test, compression strength, esistance test

Composite resin technology has evolved constantly sincethe introduction of Bis-GMA system with inorganic fillers by Bowen in 1963.

At the moment, the researches are mainly based on the development of new monomers, quantity, sizes, silanization and development of particleswith improved properties.[1].

Nanotechnology is one of the greatest achievements in composites domain, due to the fact that it can be used to manipulate the structure of materials and it also offers dramatic improvements in electrical, chemical, mechanical and opticalproperties [2, 3].

Due to the reduced size of particles and their wide distribution, there can be obtained a large increase in the fillerspercentage, resulting in reduction of the polymerization contraction and optimization of tensile strength, compression or fracture [4, 5, 8].

Composite materials represent a combination of two or more different materials from the chemical point of view, with an interface between them.

The constituent materials maintain their separate identity (at least at a macroscopical level) in composite, however their combination generates an assembly of new properties and characteristics, different from the components themselves.[6, 7 , 10, 11]

The components are: the matrix which forms the continuous organic phase, and the other main element, the armature (frame) or inorganic phase, which is added to the matrix in order to enhance or modify the properties. The armature is the discontinuous phase, evenly distributed throughout the entire volume of the matrix. [1, 9, 12]

The fibers are the element that confer to the ensemble those stress resistance characteristics. In comparisonto the matrix, the stress which can be overtaken it is much higher, while the corresponding elongation is reduced. The matrix presents an elongation and breaking resilience much higher, which ensures that the fibers break before the matrix yields.

However, it must be highlighted that the composite material is a unitary ensemble, in which the two phases operate/act together, as it is suggested by the stress-elongation curve of the composite.[13- 15, 20]

The very hard macro-filler composites,hard-finished and polished, were replaced with micro-filler composites which correspond to the aesthetic requirements, which instead are not hard enough, due to the lowercontent of filler.

The hardness, mechanical resistance, polymerization contraction and polymerization stress have been the focus of the researches in the recent years.

In certain universal composite materials or fluids, the nanotechnology has improved the maintaining of the surface gloss, also the increased resistance to masticatory forces and to wear.

Dental composites of high quality are made of resin and filler materials, including cross-linked polymer chains, such as triethylene glycol dimethacrylate and ethylene glycol dimethacrylate.[16-19, 21]

The results of recent studies are the modern composites with properties of lower contraction and lower abrasion.In addition, they are more resistant to the chemical and hydrolytic damage, have better mechanical resistance, are easily polished, they also presenting coloristic stability, being available in different viscosities, from *flowable* to *packable*. The progress in adhesive technologies domain, especially the 8th generationadhesives, has improved the longevity of restorations and alsohave reduced postoperative sensitivity. The resin adhesion agents produce an oxygeno-inhibited layer on the external surface of the composite, which is not polymerized and to which the subsequently inserted resin will adhere. [1, 20, 22, 24, 30, 36]

The use of composites targets caries, fracture or fissure lines, dyschromias, demineralizations, surface defects, exposed dentin, the dysmorphic lateral teeth, diastemas, fractured teeth, abrasions, attrition, gingival defects,

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surface wear, cracks, dental pits, developmental defects, periodontal immobilizations and ceramic fractures.

Various resin combinations such as methyl methacrylate (MMA) bisphenol A dimethacrylate (BIS-DMA), triethylene glycol dimethacrylate (TEGDMA), ethylene glycol dimethacrylate (EGDMA), and urethane-dimethacrylate (UDMA) are used to improve the properties of materials byobtaining cross-linked polymerschains.Composite resins contain glass particles in their filler to decreasethe contraction during the curing process. [23, 25-28]The filler confers properties to composites during the work phase, but also superior functional characteristics. The composites show color and translucency similar to the dental structures, so that the filler particles should have an optical index of 1.5. There are used materials such as strontium glass, barium, quartz, borosilicate, ceramics, silica oxides and prepolymerized resin.[28, 29, 31, 32]

The filler materials influence the behavior of the composites in various phases.

Characteristics of the filler particles such as size, texture, shape, surface tension, optical index, the amount and the distribution mode in the composite mass have an impact upon the properties of composite materials.

The filler has to be impregnated with resin, which limits the amount of filler that can be incorporated into the composite mass. The resin-filler particle interface is a strained area during the polymerization of the resin; therefore, the surface of these particles is treated with coupling agents to enhance the bond at the interface of the two components, preventing their separation.[33-35, 38]

Most of the physical properties are influenced by the resin-filler interface. There are three main causes of the stress at this level: resin thrust exerted by the curing contraction; the difference between elasticitymodules of resin and filler; the difference between the coefficients of thermal expansion for the two components.[36, 37, 39, 40]

The adhesion between resin and surface of the filler particles is improved by coupling agents such as vinyl-triethoxysilane and methacryloxypropyl-trimethoxysilane.There are also madechanges on the surface of filler particles to strengthen the bond interface (ex. roughening and aggregation of the particles, resulting in mechanical retention). The cracks in the composite mass appear around the filler particles, the characteristics of the interface being important for the material resistance.The larger particles prevents fractures, because they present a larger contact area between the resin and filler.[41, 32, 37]

The critical size of the filler particles is 1 m. At larger dimensions, the filler particles are visible to the human eye.As the mass of resin that embeds the particles is being worn out, the filler becomes prominent and visible,the surface of the composite becomesrough.This translates clinically by the difference in the surface aspect of a composite which has been recently finished and assembled, and the same surface appearance after a year from insertion.The particles with dimensions below 1 m do not suffer the same effect as theresin wear.[18, 19]

The exposure of the particles in the resin structure is critical to abrasion. As the resin matrix is been worn out, the surface of the filler particles is exposed to mechanical forces which result in their detachment. [25, 28]

The cavities obstruction by the layering technique minimizes the negative effects of curing contraction by producing a low contraction in each layer.Inserting the composite layers should reach as few walls as possible to further diminish the tensions.The final external layer of the restoration is oxygeno-inhibited and requires coverage to eliminate air contactand to finalize the polymerization process. The coating of composite with glycerin, followed by photo-curing is a popular technique. As an alternative, the composite may be applied in excess, and the incompletely cured layer may be removed.

Experimental part

Materials and Methods

The present study aims to evaluate three of the most used composites on dental practice.

For the flexural strength test, for each of the three materials there were prepared ten specimens(M1.1-M1.10, M2.1-M2.10, M3.1-M3.10) in the form of a rectangular bar with sizes of 25 ± 2 mm length, 2 ± 0.1 mm width and 2±0.1 mm height, as specified by ISO 4049/2000.

For the compressive strength test, from each composite there were prepared ten cylindrical specimens (m1.1-m1.10, m2.1-m2.10, m3.1-m3.10) with a diameter of 4 mm and a height of 8 mm (according to ADA specification Sp.27/1993),and for the diametrical compressive strength test, from each composite there were prepared ten cylindrical specimens(M*1.1-1.10, M*2.1-2.10, M*3.1-3.10) of 6 mm diameter and 3 mm height. These measurements were performed with the universal testing machine (Lloyd LR5K Plus).

Results and discussions

It has been shown that between the three tested nanocomposites there are statistically significant differences (p ($p<0.0001$) in terms of flexural strength (MPa), of compressive strength (MPa), diametrical compressive strength (MPa) and of the Vickers micro-hardness (kg/mm^2).

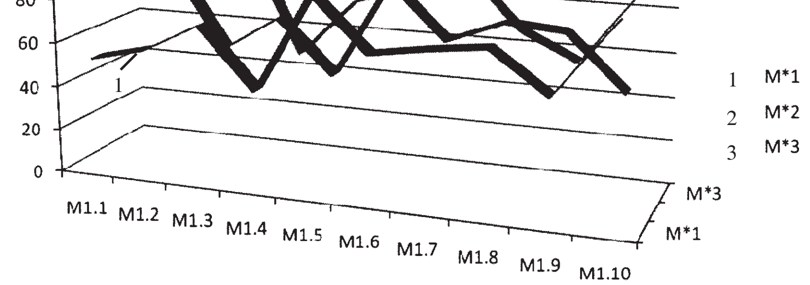

Fig. 1. Diametral strength(MPa)

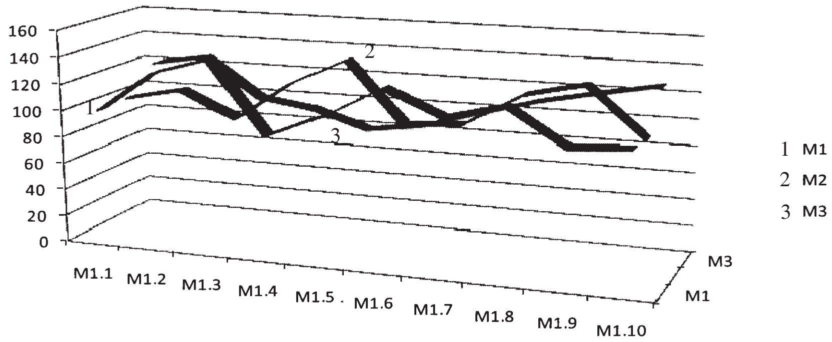

Fig.2.Flexural strength(MPa)

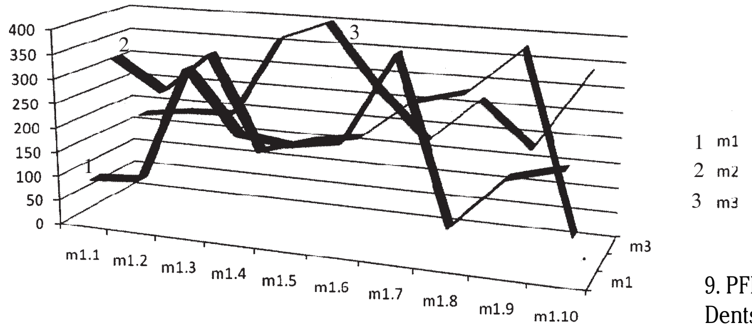

Fig.3. Compresiv strength(MPa)

Conclusions

Composite diacrylic resins with nano-filler are materials that can bring superior results aesthetically and morphofunctional the direct restorations of numerous types of crown destruction.

The consulted references highlight the benefits of this new class of restorative materials in obtaining the optimal shade, translucency, gloss similar to the natural enamel and improved properties by increased percentage of the inorganic filler.

To achieve the best results there are required: a correct choice indication; an evaluation of the patient'sbuccal terrain; strict compliance to a rigorous protocol of performing the restorations.

The studies of the mechanical and physico-chemical properties of experimental and commercial nano-composite materials, sustained by the statistical analysis, have demonstrated the influence of the percentage and of the inorganic filler type into mechanical parameters, water absorption and solubility.

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