MICROHARDNESS EVALUATION OF THREE DIRECT COMPOSITE RESINS

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ABSTRACT

This survey aimed at testing microhardness and determining its variation in case of some physiognomic coronary restoration materials frequently used in the dental practice. Material and method. The experimental researches related to the determination of microhardness variation were carried out on 3 direct dental restorative photopolymerizable composite materials (Filtek Z550-3M ESPE – nanohybrid composite, Natural Elegance- Henry Schein Inc – microhybrid composite and Charisma- Heraeus-Kulzer – hybrid composite). The microhardness testing was run in the Department of Material Engineering and Industrial Security from "Gheorghe Asachi" Technical University of Iaşi. Conclusions. The tests run showed that Filtek Z550 direct nanohybrid composite resin from 3M ESPE has the highest values of Vickers microhardness.

Keywords: composite resins, microhardness, dental restorations

INTRODUCTION

Efforts to introduce new dental composite materials that may combine the aesthetic appearance, superior mechanical properties, high biocompatibility and adherence to the dental tissues have been made in recent years. The properties and performances of dental composite resins are determined by three basic components of the composite material, namely the resin matrix, the inorganic filling and the coupling agent [1-3].

Most composites are of the hybrid type – they are made from micro fine (submicronic) and conventional particles designed to optimize both the mechanical and the surface properties.

The wide use of such composites both in anterior and posterior restorations is recommended due to its improved properties, high resistance to wear and smooth surface after finishing [4, 5].

Therefore, the appearance of composite materials and their use has meant an important step forward in terms of optimization of the treatment strategies in the field of dental disorders, given their resistance, easy handling and last but not least the disappearance of toxic effects.

STUDY GOAL

This study aimed to test microhardness and to determine the variation thereof in the case of three diacrylic composite resins largely used in the restorative therapy (table 1).

Table 1. Experiment conduct methodology

Representative class	Commercial product	Producer	Experiment code
Photopolymerising RDC	Filtek Z550	3M ESPE	10
	Natural Elegance	Henry Schein Inc.	20
	Charisma	Heraeus-Kulzer	30

MATERIAL AND METHOD

Experimental researches in terms of surface quality were conducted on three photopolymerising restorative composite

Specimens were made in the Dental Materials lab of the Faculty of Dental Medicine "Grigore T. Popa" University of Medicine and Pharmacy of Iaşi. Each specimen was made in concordance with manufacturers' specifications, with a diameter of 10×10 mm and thickness of 4 mm. The photopolymerising composites were condensed in a plastic conformator, in 2 mm layers, each layer being polymerized for 30 seconds.

The microhardness determinations were conducted on a specialized line in the Material Science labs of the Faculty of Materials Science and Engineering within "Gheorghe Asachi" Technical University of Iaşi.

Five determinations were carried out for each specimen, and the measurement of Vickers microhardness was made by means of CV Instruments 400 DM micro hardener tester (figure 1).

Figure 1. Micro-Vickers Hardness Tester, 400-DM, CV Instruments

The method for the determination of Vickers hardness uses a diamond pyramid having a square base as penetrator. Since diamond has the highest hardness of all materials used in the industry, the method may be applied without any limits to determine hardness. It is mainly recommended in the determination of hardness of materials that have their probable hardness higher than 300 daN/mm^2. For the materials diacrylic resins: a hybrid composite resin (Charisma- Heraeus-Kulzer), a micro-hybrid resin (Natural Elegance- Henry Schein Inc.) and a nanohybrid composite resin (Filtek Z550-3M ESPE).

whose hardness is lower than this value, Brinell method is used. Vickers method consists in the pressing of a penetrator at a low speed and a certain predetermined force F on the surface of the trial material. Vickers hardness, whose symbol is HV, is expressed through the ratio between the applied force f and the area of the lateral surface of the persistent trace produced by the penetrator. The trace is considered as a vertical pyramid having a square base, with diagonal d, and having the same angle at its peak as that of the penetrator.

Microhardness is calculated by the same formula as Vickers hardness:

$$HV_{0,1} = 1854{,}4\frac{F}{d^2}, [MPa]$$

where: F – pressing force; d – average value of trace diagonals left by the pyramid peak of the penetrator on the specimen surface.

To measure the two diagonals of the square print left by the diamond pyramid (Vickers penetrator), micro-hardener is provided with a micrometric eye piece with a screw, a fixed and a mobile plate, both having on them two lines arranged at 90^o. Both lines overlap on the zero position, and in any other position they will form a square which must perfectly fit the print.

All microhardness determinations were carried out in similar conditions by using a press load of 25 gf and a time for load maintaining of 25 seconds [6].

RESULTS AND DISCUSSIONS

As for the determinations for the specimen made from Charisma Heraeus-Kulzer, the highest value was obtained in the fourth determination followed in a decreasing order by the fifth, the third, the second and the first determination. The values obtained are given in table 3.

The variation of Vickers microhardness for *Charisma Heraeus-Kulzer* is graphically illustrated in figure 2.

Table 3. Values of the tests carried out on Charisma Heraeus-Kulzer specimen

Print number	Microhardness, $HV_{0,1}$	Microhardness average (StDev)
1	26.4	29.20 (2.12)
2	27.5	
3	28.9	
4	31.8	
5	31.4	

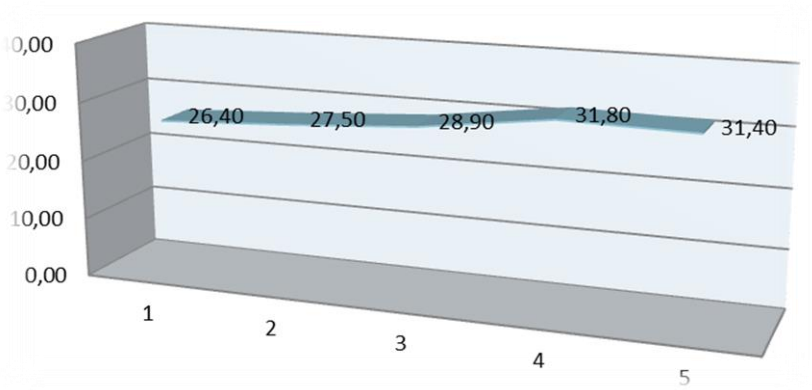

Figure 2. Variation of Vickers microhardness for Charisma Heraeus-Kulzer (hybrid RDC)

As for the determinations for the specimen made from Natural Elegance - Henry Schein Inc. the highest value was obtained in the third determination followed in a decreasing order by the fourth, the second, the fifth and the first determination. The values obtained are given in table 4.

Table 4. Values of the tests carried out on Natural Elegance - Henry Schein Inc. specimen

Print number	Microhardness, $HV_{0,1}$	Microhardness average (StDev)
1	27.2	29.58 (1.81)
2	29.2	
3	32.2	
4	31	
5	28.3	

The variation of Vickers microhardness for Natural Elegance - Henry Schein Inc. is graphically illustrated in figure 3.

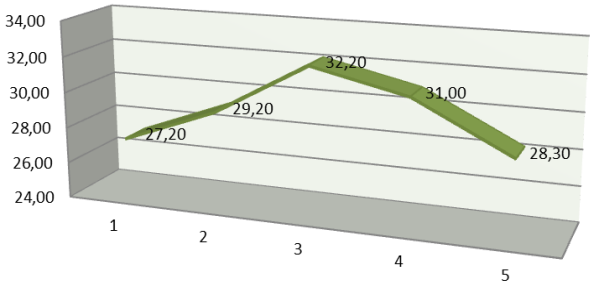

Figure 3. Variation of Vickers microhardness for Natural Elegance - Henry Schein Inc. (micro-hybrid RDC)

As for the determinations for the specimen made from Filtek Z550 - 3M ESPE (*nanohybrid RDC*), the highest value was obtained in the fifth determination followed in a decreasing order by the first, the second, the fourth and the third determination. The values obtained are given in table 5.

The variation of Vickers microhardness for Filtek Z550- 3M ESPE is graphically illustrated in figure 4.

In figure 5 we made a comparison highlighting the microhardness average for the 3 specimens.

Table 5. Values of the tests carried out on Filtek Z550 - 3M ESPE specimen

Print number	Microhardness, $HV_{0,1}$	Microhardness average (StDev)
1	68.3	65.88 (4.36)
2	65.3	
3	61.2	
4	61.7	
5	72.9	

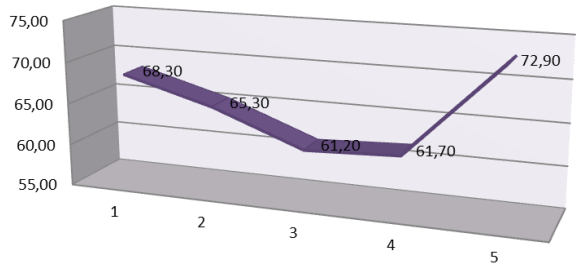

Figure 4. Variation of Vickers microhardness for Filtek Z550 - 3M ESPE (nanohybrid RDC)

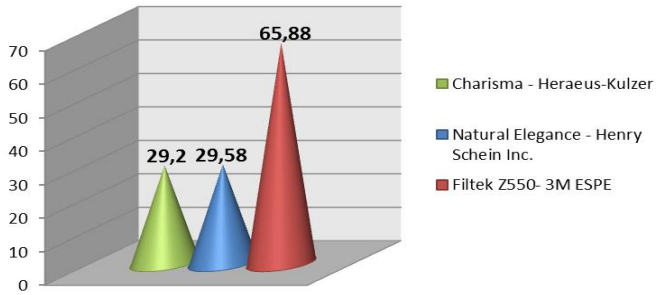

Figure 5. Variation of average values of Vickers microhardness for the materials under study

As one may notice in the graphic representation, the highest value of microhardness was obtained in the determinations carried out on the specimen made from the Filtek Z550 - 3M ESPE commercial product (nanohybrid RDC) followed by similar values for Natural Elegance - Henry Schein Inc. (micro-hybrid RDC) and Charisma Heraeus-Kulzer (hybrid RDC) commercial products.

While making an analysis of the experimental results obtained for microhardness of the materials under study and chemical composition, we may affirm that Zirconium/Silica nanoparticles present in the inorganic filling mass of the composite diacrylic resins ensures a much higher hardness than the presence of colloidal silica microparticles.

CONCLUSIONS

1. Direct composite resins are available in a wide variety of forms of presentation and for this reason the practitioner must, while selecting and using them, tale into account their composition, clinical performances, handling characteristics, and biomechanical behaviour, microhardness being an important parameter of it [3].
2. The hardness of a dental material measures its resistance to indentation by means of a harder alloy (steel or diamond).
3. The value differences between the average microhardness of the two materials belonging to class of hybrid and micro-hybrid composite diacrylic resins are not very high ($HV_{0,1}$ Charisma=29.2 and $HV_{0,1}$ Natural Elegance=29.58) since they both contain silica microparticles.
4. The presence of Zirconium/Silica nanoparticles resulted in the increase of microhardness of the nanohybrid composite diacrylic resin, Filtek Z550 ($HV_{0,1}$ Filtek Z550=65.88).
5. It is obvious that the materials having a higher microhardness will be more difficult to process by chipping which is a technology by which the mechanical finishing (grinding and polishing) of direct restorations is also performed.

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