Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 10239 - 10244
Received 05 March 2021; Accepted 01 April 2021.

An *in Vitro* Assessment of the Surface Hardness of Various Esthetic Restorative Materials

Running title: surface hardness of various esthetic restorative materials

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Abstract
This study was done to estimate the surface hardness of a Nanohybrid Ormocer-based composite with microfilled hybrid and Nanofilled composites. In this *in vitro* study 30 cylindrical specimens (4 mm × 4 mm) were made from each material in metal template; Nanohybrid Ormocer-based composite (Admira Fusion), microfilled hybrid composite (Gradia Direct,), Nanofilled composite- Filtek supreme XTE. Molds were filled in one increment with respective composites and cured using Ivoclar blue phase light-curing unit. Specimens were stored in dark container and kept dry at room temperature for 24 h before testing. Vickers hardness number (VHN) on the bottom and top areas of each sample was assessed with a microhardness tester.

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The obtained data was statistically evaluated. There was no significant difference found in Vickers hardness test. The mean value of VHN on the top and bottom surfaces indicated significant variance from each other. It was concluded that Nanohybrid Ormocer-based composite has the maximum VHN as related to other materials representing maximum degree of conversion and improved clinical presentation.
Keywords: composite, Nanohybrid, vickers hardness

Introduction

Nowadays esthetic restorations are gaining importance among patients and practitioners. Various esthetic restorative materials have been tried to improve their mechanical properties. Mechanical properties of composites are similar to that of tooth enamel [1]. Various types of composites, together with conventional, microfilled, flowable, hybrid, packable, and nanofilled, were introduced. Insufficient curing depth is the major disadvantages of resin-based composite material; because of large cavities, especially in class II restorations[2.] Hence materials are added in increments of maximum 2 mm thickness and cured.

Degree of conversion is the main feature that impacts mechanical and physical properties of dental composites. The degree of conversion in dental composite restoration is predisposed by diverse factors. These aspects comprise; power density, irradiation time, wavelength of curing light, tip size of light source, distribution, contents of organic matrix, inorganic filler quantity, type of photo initiator used, and color of the composite resins [3].

Using Nanotechnology in dentistry, nanofillers were added in composite to improve mechanical properties. A nanohybrid is a hybrid resin composite with nanofiller in a prepolymerized filler system, while nanofill is a composite resin that is consist of both nanoclusters and nanomers. The term Ormocer is an ellipsis for Organically Adapted Ceramics. An Ormocer is a hybrid molecular structure, a combination of organic and inorganic components at nanoscopic scale [4].

Different types of laboratory investigations have been introduced to evaluate dental composite resins; flexural strength and modulus of elasticity are used as an indicator for material durability under stress. These assessments can also be used to associate with the clinical permanency of composite restorations. Fracture toughness test is an alternative method to examine the material's ability under stress without fracture and crack propagation inside the material before failure[7]. Vickers hardness evaluation can be used for checking surface hardness and the mode of failure of the material. The longevity strength and the sustainability of composite restoration especially in stress-bearing area depend on the surface hardness of the material.

Hence, the aim of the present study was to estimate the surface hardness of a Nanohybrid Ormocer-based composite, microfilled hybrid and Nano filled composite restoration materials.

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Materials method

A total of 30 samples were prepared. They were allocated into 3 study groups (n = 10). Metal template was made; it had inner diameter of 6 mm and 2 mm thickness. Metal templates were placed on Mylar strips (Primo Dental Products MS500 Mylar Matrix Strips, 4″ Long × 3/8″ Wide) placed on a glass slab and were filled with respective composite material increment; nanofilled composite (Filtek Supreme, microfilled hybrid composite (Gradia Direct), nanohybrid Ormocer-based composite resin. On the upper surface, a Mylar strip was positioned and the material was flattened using a glass slide. Glass slab was detached after elimination of additional material, and cured by means of light-emitting diode (LED) (Cromalux Mega-Physik, Rastatt, Germany; 850 mW/cm^2) for forty seconds and the light cure tip held at a distance of 1 mm. The samples were then removed from the molds later it was finished and polished in the mold. With an indelible marker the top surface was marked. All models were held dry at room temperature in light proof dishes for 24 hours.

Materials used in the study were; Group A-nanohybrid Ormocer-based composite (Admira Fusion, Voco, Cuxhaven, Germany), Group-B microfilled hybrid composite (Gradia Direct, GC Corporation, Tokyo, Japan);Group-C nanofilled composite (Filtek Supreme XTE, 3M ESPE, St Paul, MN, USA). A3 Vita shade was designated for each material.

Vickers hardness test was done using a 50-g load and dwell time was 15s. In every sample, 3 indentations were done on both the bottom and top surfaces. The formula to calculate the Vickers hardness ratio of the top and bottom surfaces is as follows:

Vickers hardness ratio = bottom VHN mean value × 100 Top VHN mean value.

Statistical analysis

The statistical evaluation of data was done with two-way ANOVA test, Student's *t* test and Bonferroni test using SPSS software program, version 21.0 (SPSS, Chicago, IL, USA).

Result

The test was conducted on three experimental groups. Table 1 shows the Vickers hardness average value of top and bottom surfaces. Group I nanohybrid Ormocer-based composite showed greater hardness as compared to Group II (microfilled hybrid composite (Gradia Direct) with a *P* value 0.001 (both top and bottom surfaces). *P* Value was highly statistically significant

Table 1: Descriptive statistics and comparative analysis of top and bottom surface hardness values

Vickers hardness number				
	nanohybrid Ormocer-based composite	microfilled hybrid composite	nanofilled composite	P value

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Top surface	98.21	65.45	75.43	0.001
Bottom surface	92.05	58.43	69.46	0.001
VHR (%)	94.64	89.58	94.67	

Test used: analysis of variance (ANOVA)

Table 2 indicates the intergroup comparison on top and bottom surfaces of the depth of cure. The variance in bottom and top areas hardness was statistically substantial in both the groups. The variance in average depth of cure was not statistically substantial between I and II groups.

Table 2: Descriptive statistics and comparative analysis of depth of cure

Intergroup comparison using			
nanohybrid Ormocer-based composite	microfilled hybrid composite	Top = 65.45 Bottom = 58.43	0.000 0.000
	nanofilled composite	Top = 75.43 Bottom = 69.46	0.028 0.003
microfilled hybrid composite	nanohybrid Ormocer-based composite	Top = 98.21 Bottom = 92.05	0.000 0.000
	nanofilled composite	Top = 75.43 Bottom = 69.46	0.021 0.005
nanofilled composite	nanohybrid Ormocer-based composite	Top = 98.21 Bottom = 92.05	0.034 0.003
	microfilled hybrid composite	Top = 65.45 Bottom = 58.43	0.021 0.005

Test used- Student's t test

Discussion

Surface hardness shows abrasion resistance that prevents the materials from the creation of permanent deformities, increasing the scratch and abrasion resistance seen if the microhardness is high. So the material efficiently prevents from various forces [5].

Composite resins have excellent handling characteristics with minimal polymerization stress. According to various studies, silver amalgam and gold alloys have been used with clinical success for a century, especially as a posterior restorative material because of their good mechanical properties.

Poggio et al found lower surface microhardness with microfilled composites compared to nanofilled –ormocer composites, these results are similar to our findings [4]. Palma-Dibb et alinvestigated the microhardness of 2 polyacid-modified composite resins, 2 resin-modified glass ionomer cements, and a hybrid composite resin at different depths from the upper surface and found that RMGIC, microhardness was not affected at depths up to 2.6 mm [6].

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Vickers hardness ratio is related to the depth of cure (80%) and the degree of polymerization. A high degree of polymerization is an important issue for attaining greater mechanical and physical properties. Marginal microleakage, discoloration, and decreased bonding strength of resin composite restorations[7] are caused by inadequate polymerization.

Bajwa1 and Pathak assessed the effect of Cola drink on surface roughness of esthetic restorative materials and found Resistance to change in surface roughness is more in resin based restorative materials as compared to glass ionomer based materials [8]. Silva et al assessed the color stability (ΔE) and Knoop microhardness (KHN) of composite resins containing different compositions and concluded that fluoride content had higher color alteration (ΔE) and lower Knoop microhardness (KHN) [9].

In present study, hardness and depth-of-cure values in nanohybrid ormocer composites were higher than the other two composite samples when cured with LED light. A metal template was incorporated since the material does not stick to the mold and can be easily molded after polymerization [10].

The result of this study is based on different factors, such as amount and type of filler particles, composition of organic matrix, and degree of conversion. The outcomes examined with this study should be followed by long-term clinical studies to assure the performance of the material under routine clinical conditions. The drawback of the study was only 3 materials were compared and the study was *in vitro* evaluation. Further long term studies are needed for better clinical performance with in vivo study.

Conclusion

In this study, superior fracture resistance, high flexural strength, modulus, and higher microhardness values were reported by nanohybrid ormocer based composite compared to other microfilled composite resins.

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

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