Research Article

Comparative Evaluation of Microhardness of Nanocomposite with Microhybrid Composite: An In Vitro Study

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ABSTRACT

Introduction: Aesthetic demands are increasing the popularity of posterior composite restorations. Though multidimensional materials that bond chemically, composites have higher cost and shorter longevity compared to other restorative materials like amalgam and gold. An ideal restorative materials have properties comparable to properties of tooth surface it. An important factor is the surface microhardness of composite. Over years, composites have developed a lot from conventional composites to microhybrid and nanocomposites.

Objective: The purpose of this in vitro study was to investigate the difference in surface microhardness of nanocom-posites and microhybrid composites.

Materials and Method: The sample size consisted of 20 disks made of microhydrid (Group 1) and nanocomposites (Group 2). For testing the surface microhardness 10 disk shaped specimens each of Z350 and Z100, measuring 5 mm in diameter and 2 mm in thickness were prepared and tested using the Vickers hardness tester.

Result: In the intergroup comparison of both top surface and bottom surface microhardness, nanocomposites showed higher microhardness values (96.30 VHN and 74.21 VHN) as compared to the microhybrid composites (93.54 VHN and 72.86 VHN) that were not significant statistically.When intragroup comparisons were done for top and bottom surface microhardness, top surface showed higher value than bottom surface independent of the material used. This was statistically significant (p= 0.001).

Conclusion: Nanocomposite had higher microhardness values than microhybrid composite restorative material and within the groups, the top surface microhardness was higher than bottom surface irrespective of the composite material used. Thus, the microhardness for top surface, which is closer to the light source is significantly higher compared to bottom surface that is awayin both the materials used.

Keywords: Depth of cure; microhardness; microhybrid composite; nanocomposite.

INTRODUCTION

The popularity of posterior composite restoration is increasing because of the aestheticdemands by patients, although composites have higher cost and shorter longevity as compared to amalgam and gold.[1] The composites are multidimensional products, with atleast two chemically blend materials comprised of a resin matrix, coupling agent, filler particles and minor additives like polymerisation initiators, stabilizers and colouring agents. The resultant combina-tion of the properties was found to be superior to individual component alone.[2]

A material designed to restore lost tooth tissues, should have properties same as or comparable to properties of tooth surface it must replace.[3] An important property of restorative materials is the surface microhardness and the relative importance of hardness lies in the fact that it throws light on the mechanical properties of a material.[4] A positive correlation has also been established between the hardness and inorganic filler content of the material. Composite resins therefore must have an optimal combination of physical and mechanical properties to meet this. Over the years the composites have seen a marked improvement in the properties as compared to the conventional composites with the development of microhybrid and furthermore the nanocomposites.[3,4]

Increased filler levels in composite results in increased hardness numbers. The hardness values of resin composites have also been considered to provide an indication of their wear resistance properties and those with higher surface hardness are less prone to three body abrasive wear.[4] Surface roughness, microhardness and wear resistance of restorative materials is therefore important for clinical longevity, aesthetics and resistance to dental plaque. Furthermore, the surface hardness tests have been shown to be an indicator of the degree of polymerisation of the resin material.[5]

The purpose of this in vitro study was to investigate the difference in surface microhardness of nanocomposites and microhybrid composites.

MATERIALS AND METHOD

Ten disk shaped specimens each of Z350 and Z100, measuring 5 mm in diameter and 2 mm in thickness were prepared using the plastic mould (Dentsply). Disks were prepared by a placing a single increment of the material in the mould using a cement carrier and the material was condensed using a ball burnisher. Transparent mylar strips were placed on the top and bottom surfaces of the mould to remove the air-inhibited layer prior to polymerisation.

All the specimens were cured from the top for 40 seconds using a LED light curing unit (Smartline,Dentsply,India). The top and bottom surfaces of disks were finished using the composite finishing kit and polished using Enhance Kit to get a smooth surface for analysis. All preparations were carried out by the same operator.The polished specimens were then stored at 37°C for 24 hours until the measurements were recorded.

Vickers Hardness Tester: Model – MV 1-PC FEI was used in the study. The machine has a maximum capacity of upto 1000 gf and givesPC based Automatic measurement (Figure 2).

Evaluation of Microhardness: The Vickers hardness measurements were carried out under a load of 50 gms for 30 seconds. Three indentations were made on the top surface and three on the bottom surface of each specimen. The measurements were made for all the 3 indentations separately on the top and the bottom surfaces of the specimens and measurements were read from the computer attached to the Vickers hardness tester and tabulated (Figure 3).

RESULT

The microhardness values were recorded with Vickers hardness test carried out on 20 disk shaped samples, 10 each prepared from microhybrid composites (Group 1) and nanocomposite (Group 2) The measurements were made for all the 3 indentations separately on the top and the bottom surfaces of the specimens and measurements were read from the computer attached to the Vickers hardness tester and recorded as Vickers Hardness Number (VHN). The readings were subjected to statistical analysis using SPSS package 11.

In the intergroup comparison of top surface microhardness of microhybrid composite (Group 1) and nanocompo-sites (Group 2), the nanocomposites observed a higher

Table 1: Intergroup comparison of top surface microhardness – Student's unpaired t-test.

Group	N	Mean	Std.Deviation	t
1	10	93.5433	10.71276	0.62200
2	10	96.3067	9.07855	p=0.542

Table 2: Intergroup comparison of bottom surface microhardness – students unpaired t-test.

Group	N	Mean	Std.Deviation	t
1	10	72.8667	8.22376	0.35800
2	10	74.2133	8.58197	p=0.724 ns

Table 3: Intragroup comparison of top and bottom surface microhardness of Group 1- Student's unpaired t-test.

Group	N	Mean	Std.Deviation	t
TOP	10	93.5433	10.71276	4.84100
BOTTOM	10	72.8667	8.22376	p = 0.001 hs

Table 4: Intragroup comparison of top and bottom surface microhardness of group 2- Students unpaired t-test.

Group	N	Mean	Std.Deviation	t
TOP	10	96.3067	9.07855	5.59200
BOTTOM	10	74.2133	8.58197	p = 0.001 vhs

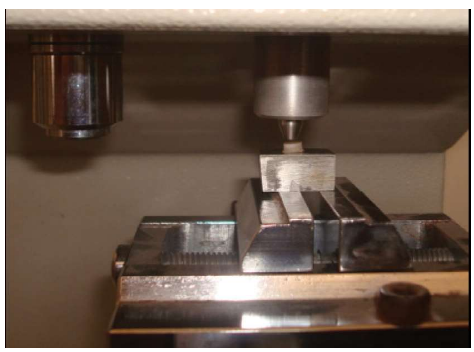

Figure 2: Testing the Microhardness by Vickers Hardness Tester.

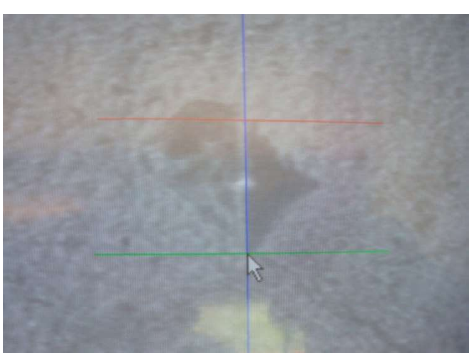

Figure 3: Evalutaion of Microhardness.

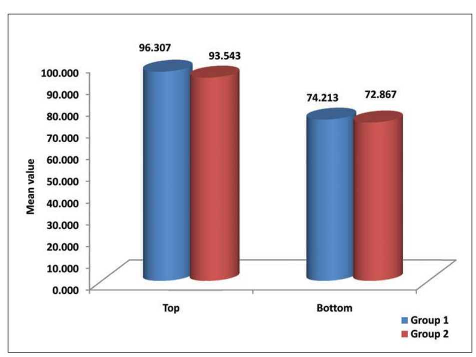

Figure 4: Intergroup and Intragroup comparison of Vickers Hardness Number.

value (96.30 VHN) as compared to the microhybrid composites (93.54 VHN). However these values were not statistically significant (Table 1). Similar to the top surface readings, in the intergroup comparison on bottom surface readings, it was observed that the nanocomposites showed a higher value (74.21 VHN) than microhybrid composite (72.86 VHN) although it was not significant statistically. The test used was Students' unpaired t-test (Table 2). The microhardness values between the top and bottom surface are significantly different (Table 3). The top surface mean microhardness value (93.54 VHN) was highly significant (p =0.001) as compared to the bottom surface (72.86 VHN). Similar result is observed with nanocomposites where the top and bottom surface microhardness values are significantly different (Table 4, Figure 4). The top surface showed microhardness value (96.30 VHN) higher as compared to the bottom surface (74.21 VHN) which was highly significant (p = 0.001) (Figure 4). It was observed that the microhardness values for the top surface that is closer to the light source is significantly higher when compared to that of the bottom surface that is away from light in both the materials used (Table 3, 4).

DISCUSSION

Microhardness is understood as the hardness of a small volume of material, derermined through measurements on special apparatus under very low loadings. It is the ratio of the used load to the indent area and is dependent on the degree of polymerisation and the organic filler content of the material.[6,7] To record microhardness three main hardness tests have been proposed - Barcol, Knoop, and Vickers. The present study recorded the microhardness utilizing the Vickers Test as there is a significant linear correlation between Vickers and Knoop hardness as both may be similarly appropriate for studying resin cements.[8,9]

The hardness depends on the degree of polymerisation hence a range of photo-polymerisation techniques have been advocated currently. This study utilized the LED unit because they have certain advantages: cordless, smaller and lighter and do not require a noisy cooling fan. Furthermore the performance of the LED lights meet the ISO standard for depth of cure and these systems appear suitable for routine clinical application for resin curing.[8,10,11] Gritsch et al[9] suggested that, concerning microhardness values, nanocomposites and microhybrid resin composites behave similarly regarding the type of curing units.

The shade of the composites also influences the degree of polymerisation. The lighter shades polymerize better than the darker shades as pigments in darker shades absorb more light and decrease the penetration of the resin matrix.[10] Therefore to have an equal depth of cure, A2 shade of both the materials were used in this study.

In the present study the top surface of materials, microhybrid composite and nanocomposite, showed statistically significant higher microhardness values as compared to the bottom surfaces. The difference between the top and bottom surface microhardnes maybe due to the fact that when light passes through the material it is dispersed and the efficacy of polymerisation in the deepest layer is compromised.[9,10] Erosoz et al concluded that an increase in distance of the light source from resin composite surface promoted a decrease in the microhardness values. Bottom side hardness is substantially lower than top surface hardness at any distance of the light tip. Similar findings have been reported in varous studies by Park et al[12] and Daniela et al.[11]

The nanocomposites showed higher microhardness value as compared to the microhybrid composites in the present study (Tables 3,4 and Figure 4) which can be due to the difference in the filler content. A positive relation has been established between the hardness and ultrastructure, size of filler particles, volume/weight fraction of filler, and chemical composition of a composite resin had an impact on its Vickers hardness.[5] This can be correlated with the findings of Diogo et al[13] and Seasmus et al[14] that most highly filled material yield more hardness value.

CONCLUSION

The following conclusions weredrawn from the present study:

1. The intergroup comparison of the between microhybrid composite and nanocomposites showed higher microhardness values for nano-composite as compared to the microhybrid composites.
2. When intragroup comparison was made for top and bottom surface microhardness, top surface micro-hardness was higher than bottom surface irrespective of the material used. This was statistically significant (p= 0.001).

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