Study the effect of different shades and thickness on surface hardness of light cure composite restoration (A Comparative In Vitro Study)

Sulaimani Dental Journal

Bassam Afram Hanna[1], Miwan Salahaldeen A. Rahman[2] & Tavga Mustafa Fars[3]

[1] B.D.S, M.Sc (Conservative Dentistry). Lecturer of Conservative Dentistry. Department of Conservative Dentistry, School of Dentistry, Faculty of Medical Science, University of Sulaimani, Iraq.
[2] B.D.S, M.Sc (Conservative Dentistry). Lecturer of Conservative Dentistry. Department of Conservative Dentistry, School of Dentistry, Faculty of Medical Science, University of Sulaimani, Iraq.
[3] B.D.S, M.Sc (Conservative Dentistry). Ass. Lecturer of Conservative Dentistry. Department of Conservative Dentistry, School of Dentistry, Faculty of Medical Science, University of Sulaimani, Iraq.

Correspondenance to;
Dr. Bassam A. Hanna
fshl1971@gmail

Abstract

Objectives: Study performed to determined the effect of cavity depth & shade of composite on surface microhardness of the restoration.

Materials and Methods: Eighty cylindrical specimens were prepared, (Group R) 40 specimens of Nano filled composanceram, divided into four subgroups(R1,2.5 mm,A1shade / R2, 2.5mm, C2 shade / R3,4.5mm, A1shade / R4, 4.5mm, C2shade). And (Group E) 40specimens of Micro hybrid, 3G SDI, divided into four subgroups as the same as first group. After curing with visible light cure 230v/50Hz, output 470 nm, measuring the Vicker Hardness number of top and bottom surface of each specimen, then analyzed by Student t-test.

Results: Showed highly significant in difference in relation between top and bottom surfaces for all subgroups,and also there was highly significant indifference in relation to different types of composite, while there was non-significant indifference in relation to difference in shade in case of thin thickness, while it was significant in difference in case of thick thickness of specimens.

Conclusions: In case of deep cavity it wise to use thinner composite increments to improve polymerization and should avoid thicker increment especially in a dark shade of composite.

Received: *October, 2014*
Accepted: *March, 2015*

Keywords: *Vicker microhardness, shade, thickness composite filling*

Cite this article as: Hanna BA, A.Rahman MS, Fars TM. Study the effect of different shades and thickness on surface hardness of light cure composite restoration (A comparative In Vitro Study). Sulaimani Dent J. 2015;2(1):42-48.

Introduction:

Composite composed of a mixture of two or more materials. Each of these materials participates to the final properties of the composite. Resin-based composite are a universal material available in dentistry as they are used in clinical application, ranging from filling material, luting agent, indirect restorations and metal facing for endodontic post and core(1,2).

Since the manufacturing of composite as restorative materials, many attempts have been made to increase the longevity of the dental restoration. Although development have been made on mechanical properties, such as wear fracture resistance have been improved, the challenged by shrinkage caused by polymerization contraction still need more scientific resolve, In addition adequate light activation pf polymers is important to ensure optimum polymerization, as incomplete curing of the deeper portion increase the risk of restoration fracture or marginal leakage(2,3).

The depth of curing is of important not only in order to reach optimum mechanical properties including hardness but also to ensure that the clinical problem do not occur due to incompletely polymerized material in the deepest part of the cavity. Hybrid or Nanocomposite contain a graded of small and colloidal silica filler particles to achieve an optimal balance among the mechanical properties of strength, polymerization shrinkage, wear resistance and polishability(3-5).

Dental composite restorations have a major controversy: the degree to which the composite cure that is proportional to the amount of photoactivation to which they are exposed. So, the composite will polymerize to a depth which proportion with the penetration of a light beam in the bulk material. This depth of cure has a significant influence on both physical and biological properties of restorations.The depth of cure is the thickness of the material to which the light can harden(6-8).

Although there exists no universal agreement definition concerning depth of cure and how to determine it quantity, there is some kind of acceptance that depth of cure is limited to that distance from the top surface of sample where no more resin material can be scratched off. Because dental fillings need a maximum polymerization level, many investigators have studied the effect of different factors on the depth of cure(9).

The depth of cure was affected by incorporation and composition of a composite rather than the irradiance from light units The hardness of composites decreased with increasing the depth. At the composite surface, filler type, exposure duration and resin shade predominated as the most influential factors, respectively(10,11).

The cure of outer surfaces of photoactivated restoration was not greatly affected by light intensities but curing of the inner parts of these materials was affected by light intensities(12).

The factors in close relation effect to the surface microhardness values of restorative materials include the filler volume, composition resin type, and polymerization degree. A reduced polymerization is associated with a higher affinity to intrinsic discoloration due to colorants under clinical condition(13).

However, hardness can be defined as the ability of the material to resist permanent surface indentation, penetration, and abrasion. Hardness is indicative of the ease of finishing of a structure and its resistance to scratching(13,14).

Besides, the indentation produced on the surface of a material from an applied force of a sharp point or an abrasive particle results from the interaction of numerous properties. Among the properties that are related to the hardness of the material, there is strength, proportional limit and ductility. The hardness of material such as composite resin can be determined by Vickers, and Knoop tests, which are classified as microhardness tests in(15,16).

The purpose of this study was to evaluate the influence of shade, types and thickness of filling on the hardness of composite resins.

Materials and Methods:

A clear cylindrical specimens (16 mm in diameter, a package strip of drug tablets) used as a mold to prepare the specimens (figure 1).

To resemble the shade of dentine and enamel, the outer surface of the mold(boundary, bottom of the base) painted by the white color nail painting (figure 2).

The molds filled avoiding leaving bubbles by putting the mass in the center of the mold and moving it toward the boundaries so that all volume will be filled homogeneously.

Figure 1: Package strip of drug tablet

Figure 2: The boundary and bottom coated by white nail paint

Stripe of a cellulose acetate placing on top, A glass slab pressed on the top of this to express the excess material, Then the specimens were cured from one end of the mould(superficial part) for 30seconds (figure3).

The specimen light cured followed the manufacturer’s instructions using a light system (Polil, Italy). The power output density used is 230v/50Hz, output 470 nm/, where the tip of light unite 1mm distance from the top surface.

Samples Grouping:

1-Group R: The specimens will be filled by (Nano filled composite, composan ceram, (figure4,5)

- Subgroup R1: 10 Specimens, Depth of mold 2.5mm, Used shade of A1.
- Subgroup R2: 10 Specimens, Depth of mold 2.5mm, Used shade of C2.
- Subgroup R3: 10 Specimens, Depth of mold 4.5 mm, Used shade of A1.

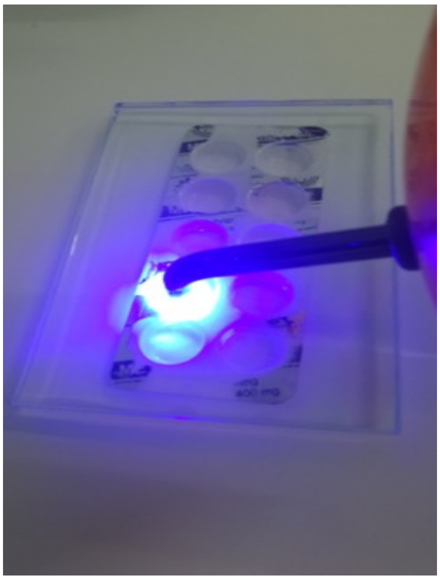

Figure 3: Using light cure for polymerization of each specimen separately

Figure 4: Nano filled composite Shade A1

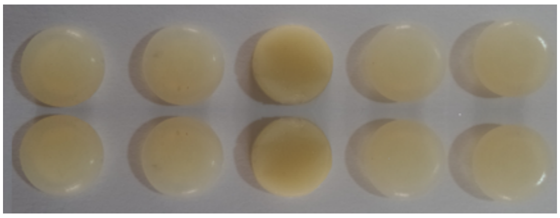

Figure 5: Nano filled composite shade C2

Figure 6: Screen monetary representing the indentation

Figure 7: Digital microhardness tester

Subgroup R4: 10 Specimens, Depth of mold 4.5 mm, Used shade of C2.

2-Group E: The specimens will be filled by (micro hybrid, 3G SDI Composite).

- Subgroup E1: 10 Specimens. Depth of mold 2.5mm, Used shade of A1.
- Subgroup E2: 10 Specimens, Depth of mold 2.5 mm, Used shade of C2.
- Subgroup E3: 10 Specimens, Depth of mold 4.5 mm, Used shade of A1.
- Subgroup E4: 10 Specimens, Depth of mold 4.5 mm, Used shade of C2.

Surface Hardness test

Vickers Hardness test is among the oldest methods used to test material used in dentistry , The method depend on indenting the test material with a diamond indenter in the form of a pyramid with a square base and an angle of 136 degrees.

The full load 100gm is applied for 10 seconds, then measured the diagonal of each indentation that appear on the screen (figure6).

The Vicker Hardness measured by using digital microhardness tester (figure 7).

The surface hardness will be measured twice the time for each sample.

1-*HV of the top surface (superficial layer).

2-#HV of the bottom surface (inferior layer).

Results:

Table (1) representing the descriptive statistic (Mean, minimum value, maximum value and standard deviation) and inferential statistic through Student t-test to comparison between each subgroup in relation to top and bottom surface of Nano filled composite.

Minimum value appears in a subgroups (R4#), While the maximum value found in a subgroup (R3*), and the comparison were highly significant in the difference between the top and the bottom surface among all subgroups.

Table (2) representing the descriptive statistic (Mean, minimum value, maximum value and standard deviation) and inferential statistic through Student t-test to a comparison between each subgroup in relation to top and bottom surface of micro hybrid composite.

Minimum value appears in a subgroup (E1#), While the maximum value found in a subgroup (E3*),and the comparison were highly significant in the difference between the top and the bottom surface among all subgroups.

Table (3) representing the descriptive statistic (Mean, minimum value, the maximum value and standard deviation) and inferential statistic through Student t-test to a comparison between different composite materials of the same thickness and shade.

Minimum value appears in a subgroup (ME1), While the maximum value found in a subgroup (MR3), and the comparison were highly significant indifference among all subgroups.

Table(4) representing the descriptive statistic (Mean, minimum value, maximum value, standard

Table 1: Descriptive statistic And student –t test Nano filled composite in relation to the thickness.

Groups	Mean ± Std. Deviation	Minimum	Maximum	P values
R1*	62.08±0.09	61.9	62.2	<0.001
R1#	59.87±0.09	59.7	60.0	
R2*	62.17±0.266	62.0	62.9	<0.001
R2#	59.80±0.115	59.6	60.0	
R3*	62.18±0.270	62.0	62.9	<0.001
R3#	55.90±0.115	55.7	56.1	
R4*	62.06±0.107	61.9	62.2	<0.001
R4#	55.01±0.119	54.8	55.2	

Table 2: Descriptive statistic And student –t test of Micro hybrid composite in relation to the thickness.

Groups	Mean ± Std. Deviation	Minimum	Maximum	P values
E1*	57.22±0.078	57.1	57.3	<0.001
E1#	54.60±01.44	50.5	55.2	
E2*	57.16±0.084	57.0	57.3	<0.001
E2#	54.96±0.096	54.8	55.1	
E3*	57.23±0.094	57.1	57.4	<0.001
E3#	52.87±0.082	52.8	53.0	
E4*	57.19±0.073	57.1	57.3	<0.001
E4#	52.71±0.087	52.6	52.8	

Table 3: Descriptive statistic, Student t-test between subgroup in relation to

Groups	Mean ± Std. Deviation	Minimum	Maximum	P values
MR1	60.97±1.13	59.70	62.20	<0.001
ME1	56.91±1.67	50.80	57.30	
MR2	60.98±1.23	59.60	62.90	<0.001
ME2	56.06±1.13	54.80	57.30	
MR3	59.04±3.22	55.70	62.90	<0.001
ME3	55.05±2.23	52.80	57.40	
MR4	58.53±3.61	54.80	62.20	<0.001
ME4	54.95±2.29	52.60	57.30	

Table 4: Descriptive statistic and Student t-test between subgroup in relation to shade

Groups	Mean ± Std. Deviation	Minimum	Maximum	P values
MR1	60.97±1.13	59.70	62.20	N. Sig.0.087
MR2	60.98±1.23	59.60	62.90	
MR3	59.04±3.22	55.70	62.90	Sig .0.043
MR4	58.53±3.61	54.80	62.20	
ME1	56.91±1.67	50.80	57.30	N.Sig.0.058
ME2	56.06±1.13	54.50	57.30	
ME3	55.05±2.23	52.80	57.40	Sig.0.039
ME4	54.95±2.29	52.60	57.30	

deviation) and inferential statistic through Student t-test to a comparison between subgroups of different shade but with the same composite and thickness.

Minimum value appear in subgroup (ME1), While the maximum value found in subgroup(MR3), and the comparison were non-significant in difference between subgroup(MR1 &MR2) and(ME1&ME2),While it were significant in difference between subgroup (MR3&MR4) and (ME3&ME4).

Discussion:

This study evaluated the influence of the resin composite types, shades , and the thickness (depth) of composite filling on the microhardness of the top and the bottom resin composite surfaces, the results of this study showed that these three factors were capable of affecting polymerization microhardness.

Regarding the depth of the cavity, the results indicate that the sample thickness had no effect on the top surface hardness for both two types of resin composites, as expected. The top surface hardness of composites were less independent of light intensity than the bottom surface. The top surface is actually receiving the maximum energy from the curing light[3,12,17].

In relation to the bottom surface, when comparing the microhardness with top surface there were statistically highly significant in differences for all subgroups. These results come with the suggestion stated by Moor et al; 2008 who stated that the composite resin increments should be thinner than 2 mm are more suitable for achieving adequate polymerization in bottom surface for both Nano filled and micro hybrid composite resin., in which the light-curing tip is 1mm distant from the composite resin, as in deep restorations, was confirmed. The composite resin is known to be capable of dispersing the light; thus, when light passes through the bulk of the composite, the irradiance is reduced due to light scattering caused by filler particles and resin matrix[4,7,8].

Regarding types of the composite resins, the results were generally dependent on the properties of the material evaluated, especially with regard to filler features(Nano filled and micro hybrid). The Nano filled composite (Group R) for instance, presented the highest top and bottom VK values which were highly significant in differences from Micro hybrid composite (Group E), probably because of its large particles and the highest filler content[5], these particles when packed together result in a precisely engineered mixture that allows light transmission for the deepest layers[17]. These results come with an agreement with Rueggeberg et al; 1993 who concluded that the filler type is one of the most influential factors in the depth of cure.

Regarding shade of composite was also consider as factor affect on microhardness, Apparently, the darker shade C2 in subgroups (MR2, MR4, ME2 & ME4) influenced the passage of the light through the composite, and the light power density produce by light cure unit was not enough to reach a minimum degree of conversion especially in deep cavity due to the effects of colorants substances added to the darker shade of composite[19].

In case of subgroup (MR4 & ME4), the hardness results observed in the superficial areas of the composite might be explained by the fact the light easily excites the surface of light cured composite. However with the increase of composite depth part of this light is spread, absorbed ,or its passage become more difficult because of the increase of density of polymer formed which reduces the activation of camphor quinone molecules[20,21].

Results showed that resin shade is a factor that can alter polymerization efficacy. In this study, A1 composite (Nano filled and micro hybrid) showed highest hardness means and was statistically non-significant in difference from C2 in thin thickness like subgroups(MR1 &MR2),(ME1 &ME2), while it were statistically significant in difference in case of deep cavity(thick thickness) like subgroups (MR3 &MR4), (ME3 &ME4). This may be due to Light transmission through the dark shades is diminished because of opacity[19].

Opaque shades decrease the capacity of the light to penetrate into the bulk of the resin composite[21], the light intensity is greatly reduced due to light scattering, thus decreasing the effectiveness of cure at the bottom surface[22].

These results confirm the observation made by Aguiar et al;2006[23], who reported higher hardness values for the composite shade A1 in comparison with C2.

Conclusions:

Within the limits of this study, it can be concluded that:

1. Resin composite has the capacity of reducing light penetration and, consequently, polymerization effectiveness of the bottom surface of the sample.
2. In deep cavities, it is wise to use thinner composite resin increments to improve polymerization at the bottom surface.
3. The light curing method including variations in the depth of cure, and the composite shade influence the composite microhardness.
4. Clinicians should avoid thicker increments when working with composite restorations. Extended light-curing time might be indicated depending on the composite shade and on the light-curing device.

References:

1. *Rawls RH and Upshaw EJ. Restorative resins. Phillips'science of dental material 11th Ed., Chapter 15, pp. 399-441, 2003.*
2. *Moon HJ. Effect of depth of cure on marginal adaptation. J Oral Rehabil, 2004; 31: 258-64.*
3. *Moore BK, Platt JA, Borges G, Chu TMG and Katsilieri I. Depth of cure of dental resin composites: ISO 4049 depth and microhardness of types of materials and shades. Oper Dent.2008; 33 (4); 408-412.*
4. *Flury S, Hayoz S, Peutzfeldt A, Hüsler J and Lussi A. Depth of cure of resin composites: Is the ISO 4049 method suitable for bulk fill materials? Dent Mater. 2012; 28; 521–528.*
5. *Groninger AIS, Soares GP, Sasaki RT, Ambrosano GMB, Lovadino JR and Aguiar FHB. Microhardness of nanofilled composite resin light-cured by LED or QTH units with different times. Braz J Oral Sci. 2011; 10 (3): 189-192.*
6. *Kwon YH, Kang SI, Park JK and Kim HI. Effect of irridiation mode on polmerization of dental composites. J Biomed Mat Res. 2006; 30: 470-77.*
7. *Rueggeberg FA, Caughmau WF and Curtis JW. Factor affecting cure at depths within light activated resin composite. Am J Dent. 1993; 6(2):91-5.*
8. *Lelaoup G, Holoet EP, Beoelman S and Devaux J. Raman Scattering Determination of the depth of cure of light activated composites. J Oral Rehabil, 2002; 29: 510-15.*
9. *Swartz ML, Li Y, Phillips RW, Moore BK and Roverts TA. Effect of filler content and size on properties of composite. J Dent Res 1985; 64: 1396 –401.*
10. *Han L, Okamoto A, Fukushima M and Okiji T. Enamel microcracks produced around restorations with flowable composites. Dent Mater J. 2005; 24:83-91.*
11. *Manhart J, Kunzelmann KH, Chen HY and Hickel R. Mechanical properties of new composite restorative materials. J Biomed Mater Res.2000; 53:353-61.*
12. *Obici AC, Sinhoreti MA, Sobrinho L, Góes MF and Consani S. Evaluation of depth of cure and Knoop hardness in a dental composite photo-activated using different methods. Braz Dent J. 2004; 15(3):199-203.*
13. *Aguiar FH, Andrade KR, Leite Lima DA, Ambrosano GM and Lovadino JR. Influence of light curing and sample thickness of microhardness of a composite resin. Clin Cosmet Investig Dent. 2009; 6 (1):21-5.*
14. *Clifford SS,Roman K, Tantbioion D and Versluis A. Shrinkage and hardness of dental composite acquired with different curing light sources.Quintessence Int. 2009;40(3):203-14.*
15. *Nishimaki M, Depth of cure& hardness of indirect composite materials polymerized with two metal halide laboratory curing unites. J Oral Sci. 2012 ;5 4(1): 121-5.*

16. *Vicker Hardness Number Test Equations Formulas Calculator Material Science Hardness Testing,pencil haedness tester, hardness of thin film, coating inseption instrument. , 2013.*
17. *El-Nawawy M, Koraitim L, Aboueletta O and Hegazi H. Depth of cure& microhardness of Nanofilled packable and hybrid dental composite resin.American journal of biomedical engenering. 2012;2(6):241-250.*
18. *Rueggeberg FA, Caughman WF, Curtis J and Davis HC. Factors affecting cure at depths within light activated resin composites. Am J Dent. 1993; 6(2):91-5.*
19. *Yap AU, Soh MS and Siow KS. Effectiveness of composite cure with pulse activation and soft-start polymerization. Oper Dent. 2002; 27:44–9.*
20. *Istifan J.Effect of light curing tip distance and resin shade on microhardness of a hybrid resin composite, Dent. Res J. 2012; 9(6): 735–740.*
21. *Camila Silveira de Araújo, Marcelo Thome Schein, Cesar Henrique Zanchi, Sinval Adalberto Rodrigues, Flavio Fernando Demarco, Composite resin microhardness: the influence of light curing method, composite shade, and depth of cure. The journal of contemporary dental practice. 2008; 9(4):43-50.*
22. *Ruyter IE and Oysaed H. Conversion in different depths of ultraviolet and visible light activated composite materials. Acta Odontol Scand. 1982; 40:179–92.*
23. *Aguira FH, Lazzari CR and Lima DA, Effect of light curing tip distance and resin shade on microhardness of a hybrid resin composuite. Pesqui Odontol Bras .2005; 19:302-6.*