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Vicker's Hardness and Compressive Strength Evaluation of a Dental Composite Resin Polymerized by Conventional Light and Argon Laser

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Abstract : Introduction : This is in vitro study aimed to evaluate the micro-hardness and compressive strength using three light cure units (Halogen light ,Light emitting diode LED ,Argon laser) to cure two new widely used hybrid composite resin restorative (Composan LCM , SwissTEC).
Methods : this study was performed by using two stainless steel matrixes ,matrix with 6 mm diameter and 2 mm thickness for micro- hardness test according to ISO 4049/2000 ,and matrix with 3 mm diameter and 6 mm thickness for compressive strength test according to ISO 9917. 36 samples has been prepared divided into 12 groups and curing with irradiation time (10,20)s ,micro-hardness and compressive strength has been tested for all samples.
results : the result analyzed statisticaly by using SAS2012 ,ANOVA and T test for All studied factors showed statistically significant differences ($p<0.05$) , the samples that cured by Argon laser had the highest mechanical properties from all the composite resin tested , the mechanical properties enhanced increasing irradiation time.
Conclusions : Argon laser is more efficient for curing than Halogen light and LED, and the mechanical properties enhanced with increasing the irradiation time.
Keywords: composan LCM, swissTEC, Argon laser, micro-hardness, compressive strength.

Introduction

Composite restorative materials are used widely in dental treatment and commonly used to replace the damaged or lost parts of a tooth. They are two types of resins, chemically cured and light cured dental resins . The light cured type is widely used because of easy control for the polymerization process and the colour stability of the restoration. The composite dental resins contain three phases: the first phase is the organic phase (matrix) which is the Bisphenol Glycidyl Methacrylate (Bis-GMA) and Urethane Dimethacrylate (UDMA) resin[1].The second phase is the inorganic dispersed phase or fillers and often-used silica, quartz, glass, lithium alumino silicates etc. The filler particles are added to the organic phase to improve the physical and mechanical properties of the organic matrix, so incorporating as high a percentage as possible of filler is a fundamental aim. The filler reduces the thermal expansion coefficient and overall curing shrinkage, provides radio-opacity, improves handling and improves the aesthetic results. The third phase is the coupling agent which isan organosilane to bond the filler to the organic resin ;and this agent is a molecule with silane groups at one end (ion bond to SiO2) and methacrylate groups at the other (covalent bond with the resin)[2]

The curing process can be done by several systems of light cured units. Light cured units emit visible light that is located within the range of blue 410-500 nm [3]. The technical units are halogen light ,LED and

Argon laser. Current studies are focusing on the use of Argon laser because it seems to be ideal for the polymerization process since its wavelength is of 472 nm and the photo initiator Camphorquinone with broad peak activity in 470 nm[4] ,in addition coherency , low beam divergence , high collimation of the emitted beam that enable it to penetrate deeply into the cured mass[4,5] and provide a large degree of conversion of monomers then enhance physical properties[5].

The objective of the present study is to test two important mechanical properties micro-hardness and compressive strength of the cured composite resin by using three light curing units Halogn light, light emitting diode(LED) and Argon laser with different light intensities and different exposure times .

The hardness indicates the ease of finishing of structure ,polishing, it is necessary for esthetic purposes and that any scratch lead to premature failure .The hardness is influenced by several factors, including fractional size of filler ,the type of composite resin and the degree of polymerization. After the process of interaction, the presence of monomers joint interaction leads to shortage of hardness values [6]. Compressive sterngth isvery important mechanical properties of core buildup material,

Materials and methods:

Light cure dental composites (Composan LCM, SwissTEC) shade A1 was used to develop the tested samples. The information about this materials are listed in Table (1) according to the leaflet.

Table (1):composite resin restoratives

Material	Type	Fillers% by volume	Filler % by wt	Particles size range	Manufacture
Composan LCM	Micro hybrid	60%	76.5%	0.05-2 µm	(PROMEDICA Domagkstr 24537,Neumunster /Germany)
(SWISSTEC	Micro hybrid	59%	78%	1 µm	(Coltene®/Whaledent AG Feldwiesenstrasse 20 Altstatten/Switzerland)

The experimental units consist of (3) samples for each test ,n=3,and the tested were analyzed staticallyby using SAS 2012 ,the samples for each test polymerized with irradiation time (10-20 s).

Samples of cured composite with 6 mm diameter and 2 mm thickness for hardness test according to ISO4049/2000[7] and 3 mm diameter and 6 mm thickness for compressive strength according to ISO 9917[8] ,the sample prepared by using a stainless steel matrix ,samples prepared by placing the matrix on a translucent glass slide ,the micro hybrid resin composite was placed in the matrix in a black increment after that a transparent polystyrene strip was placed up on the matrix and the transparent polystyrene strip were changed every light curing

The light cure units used (Halogen light ,LED, Argon laser), The information about each units are listed in Table (2) according to the user's manual

Table (2): Light cure units

Light cure unit	Type	Intensity	Manufacture
Halogen light	Coltolux ®50 (Coltene GmbH Fischenzstrasse 39 D-78462Konstanz) .	250 mW	Germany
LED light	Fashion FJ22 Char-mounted on dental unit	250 mW	China
Argon Laser	Laser physics	168 mW	USA

Hardness Testing was conducted by using a device (TH-717 Digital Micro Hardness) with load (5N) where load remains hanging over the sample period (10 s) is then lifted.

The measurement of compressive strength was conducted by using a compressive strength device (Microcomputer Controlled Universal Testing Machine). With capacity of (5KN) (Model, WDW-56) It made in China (Ser. NO. 0536).

Results:

Vicker micro-hardness and compressive strength for 36 samples divided in to 12 group n=3 has been tested after 24 h storage, ,the tested were analyzed by using SAS2012 , the data were analyzed by ANOVA ,T test .The mean of micro-hardness for all samples has been shown in the tables (3,4)

Table (3): mean of micro-hardness (Mpa) for SwissTEC

Groups	Meanof micro-hardness(Mpa) for upper face	Mean of mico-hardness(Mpa) for lower face
10 s H	71.44	68.48
20 s H	77.82	71.71
10 s LED	72.88	69.06
20 s LED	75.76	71.71
10 s Laser	80.08	78.78
20 s Laser	83.83	82.10

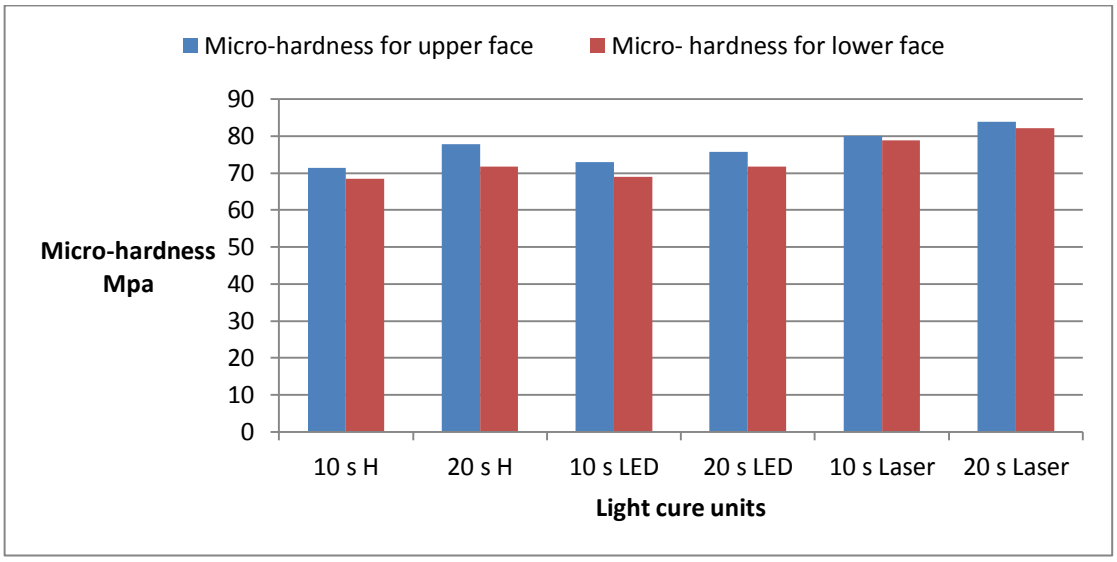

Fig (1): micro-hardness for upper and lower face for SwissTEC

Table (4): mean of micro-harness (Mpa) for composan

Groups	Mean of micro-hardness(Mpa) for upper face	Mean of mico-hardness(Mpa) for lower face
10 s H	73.71	70.49
20 s H	79.80	73.72
10 s LED	75.89	71.89
20 s LED	77.75	73.72
10 s Laser	81.78	80.873
20 s Laser	84.82	84.19

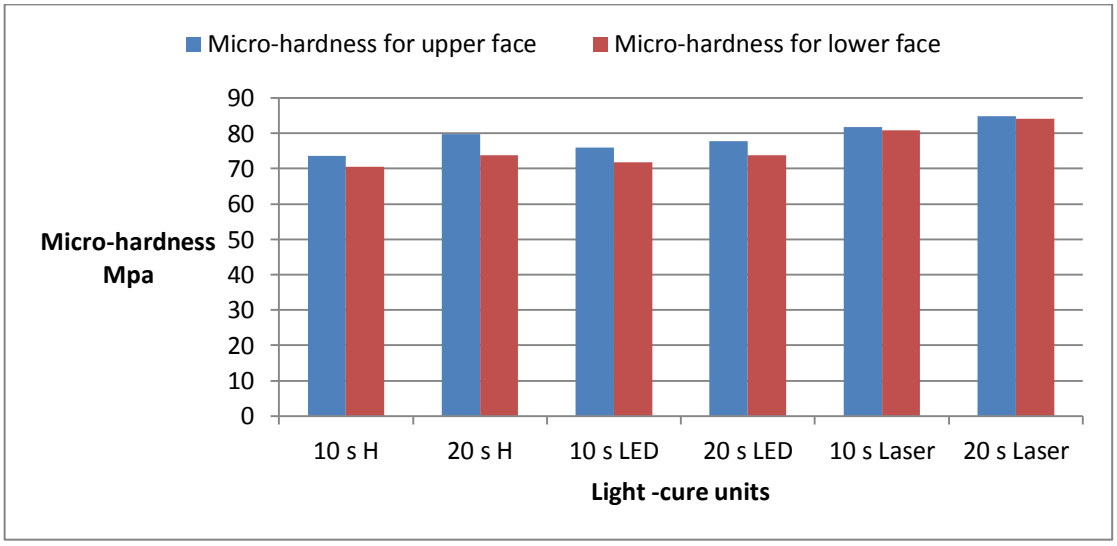

Fig (2): micro-hardness for upper and lower face for Composan LCM

All studied factors showed statistically significant differences ($p<0.05$) , the samples that cured by Argon laser had the highest hardness among all the composite resin tested ,And fig (1) showed that for all light cure units the micro –hardness increased with increasing irradiation time.

Mean of compressive strength values for all sample are shown in tables (5,6) and figs.(3,4). Result showed significal increases of compressive strength values for all sample cured by Argon laser and with irradiation time 20 s

Table (5): compressive strength (Mpa) for swissTEC

Groups	Mean of compressive strength
10 s H	178.67
20 s H	206.33
10 s LED	181.33
20 s LED	208.33
10 s Laser	198.00
20 s Laser	219.33

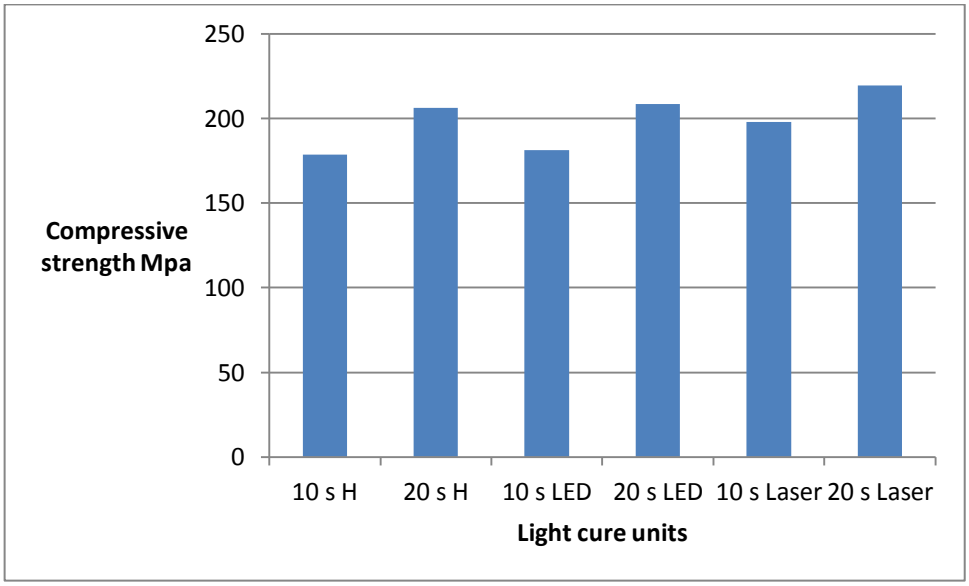

Fig .(3): compressive strength for SwissTEC

Table (6): compressive strength (Mpa) for Composan LCM

Groups	Mean of compressive strength
10 s H	180.00
20 s H	207.67
10 s LED	182.67
20 s LED	211.00
10 s Laser	200.33
20 s Laser	213.22

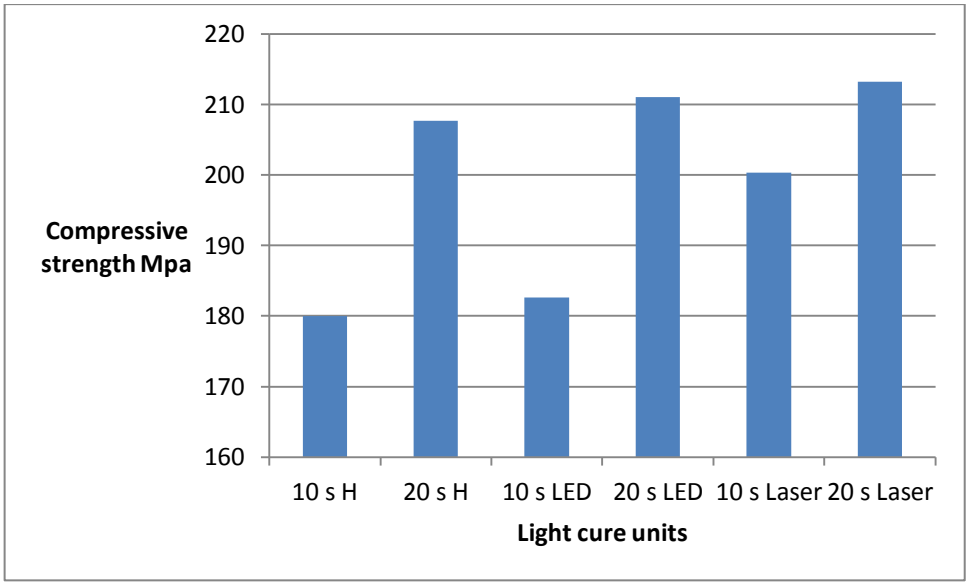

Fig .(4): compressive strength for Composan LCM

Discussion:

In recent year light cure composite resin have been widely used as a restorative material ,the knowledge of the physical properties of composite resin is so important to understand the mechanical behavior and clinical loading conditions ,mechanical properties related with the adequate polymerization of composite resin ,many factors influence the adequacy of polymerization process such as amount of monomers , filler and initiator ,wave length and intensity of incident light ,irradiation time ,temperature during polymerization ,there are many light cure units used photo polymerization of light cure dental composite ,in this study three light cure units (Halogen light ,LED, Argon laser) has been used to curing dental composite ,the result showed that the long irradiation time more efficient for polymerization than short irradiation time, long irradiation time diffusion in deep portions of the sample and let more monomer convert to polymer and this provide good polymerization and then good mechanical properties , the result of micro- hardness test , the argon laser unit shown to be more efficient in curing the composite resin where as both halogen light and LED yielded lower micro –hardness values,this result agreement with [9] which attributed the reson to the fact that the Argon laser ability to polymerization the sample is more efficient than conventional light cure units, the Argon ion laser has been describe as a promising source of curing light ,is highly absorbed by the initiator present in the composite resin [10,11] , further more Argon laser provide bond strength 21-24% greater than those of the conventional curing light system [12] , and the results of our study do not agree with study by [Katia M.,etal,2009], from the result showed that less significant differences between micro-hardness values for upper and lower face of the samples curing by Argon laser but in case of Halogen light and LED we notice that high significant difference this because of high power intensity for Halogen light and LED might have led to rapid formation of a network in the superficial layer of composite resin ,might which have reduce the transmittance throughout the bulk material ,due to changes in the optical properties of this zone [13,14].

Compressive strength is one of the most important mechanical properties for dental restorative material the result in this study showed that the samples that cured by Argon laser have higher compressive strength than Halogen and LED ,due to good polymerization that promote by Argon laser , this agreement with 9,in this study the ISO slandered for sample preparation was followed its very important n compressive strength test the cross head speed of the universal testing machine is so important in the result ,in this study the cross head speed (0.5 cm/min) like some research [15] .this study was a basic research for evaluation and comparison of the micro-hardness and compressive strength of two new composite resins which have introduced to the market in conclusion this study reported that the Argon laser can promote a greater mechanical properties for composite resin[16-18].

Conclusions

Argon laser is more efficient for curing than Halogen light and LED, and the mechanical properties enhanced with increasing the irradiation time.

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