ISSN: 1812–1217

Evaluation of the Surface Roughness for Three Different Types of Composite Resin Materials Using (Sof–Lex) Finishing and Polishing Systems: A Comparative Study

Sabah A Ismail
BDS, MSc (Asst. Prof.)

Department of Conservative Dentistry
College of Dentistry, University of Mosul

Rajaa T Suliman
BDS, MSc (Asst. Lec.)

Department of Conservative Dentistry
College of Dentistry, University of Mosul

الخلاصة

الأهداف: لتقييم خشونة السطح لثلاث نوعيات مختلفة من الحشوات الراتنجية المحفزة ضوئيا" باستخدام نظام (Sof-Lex) نظام صقل، دراسة باستخدام جهاز (profilometer). **المواد و طرائق العمل:** بمجموع ثلاثون قرص من حشوة الراتنج يتم تحضيرها من ثلاث نوعيات مختلفة من حشوات الراتنج تتضمن ثلاث مجاميع . المجموعة الأولى: عشر عينات يتم تحضيرها من مادة حشوة الراتنج المحفز ضوئيا"–(Tetric n–Ceram, Ivoclar–Vivadent Liechtenstein) nano hybride المجموعة الثانية: عشر عينات يتم تحضيرها من مادة حشوة الراتنج المحفز ضوئيا" (Arabesk – Voco, Germany) microhybride composite resin المجموعة الثالثة: عشر عينات يتم تحضيرها من مادة حشوة الراتنج المحفز ضوئيا" (polyglass Solitaire – 2, (Heraeus, Kulzer, Germany) . يتم إجراء اللمسات الأخيرة و صقل قالب الراتنج باستخدام نظام صقل (Sof-Lex) العينات يتم فحصها لقياس خشونة السطح باستخدام جهاز profilometer . **النتائج:** حشوة الراتنج Tetric n–Ceram أظهرت اقل معدل خشونة سطح (0.112 µm)، بعد ذلك تأتي حشوة الراتنج Arabesk (0.150 µm) بينما حشوة الراتنج Solitaire – 2 أظهرت اعلى معدل خشونة (0.341 µm). **الأستنتاجات:** التحليل الأحصائي للدراسة أظهر ان حشوة الراتنج Tetric n – Ceram أفضل صقلا ، وأظهر اقل معدل خشونة كحشوة راتنج.

ABSTRACT

Aim: To evaluate the surface roughness of three different types of light activated composite resin using (Sof-Lex) – polishing system, a profilometer study. **Materials and Methods:** A total of 30 resin composite disks were prepared from three different types of composite resin include 3 – groups. Group I: 10 specimens were prepared from light activated nano hybride (Tetric n – Ceram, Ivoclar – Vivadent – Liechtenstein). Group II: 10 specimens were prepared from light activated microhybride composite resin (Arabesk – Voco, Germany). Group III: 10 specimens were prepared from light activated polyglas composite resin (Solitaire – 2, Heraeus, Kulzer, Germany). The resin blocks finished and polished using (Sof – Lex) polishing system. The specimens were analyzed for surface roughness using "Profilometer". **Results:** Tetric n – Ceram composite resin showed the lowest roughness average (0.112 µm) followed by Arabesk composite (0.150 µm), Solitaire – 2 composite resin showed the highest roughness average (0.341 µm**). Conclusions:** Tetric n– Ceram (nano-hybride) was the best polished composite resin, showed the least roughness average.

Key Words: Surface roughness, composite resin, profilometer.

Ismail SA, Suliman RT. Evaluation of the Surface Roughness for Three Different Types of Composite Resin Materials Using (Sof – Lex) Finishing and Polishing Systems: A Comparative Study. *Al–Rafidain Dent J*. 2013; 13(2): 221-227.

Received:11/5/2011 ***Sent to Referees:*** 17/5/2011 ***Accepted for Publication:***26/10/2011

INTRODUCTION

Composite is a heterogeneous material that is composed of three major components (resin matrix, filler particles and saline coupling agent).[1]

Since 1960 dental composite introduced in dentistry. They have undergone a lot of changes in order to become a restorative material with acceptable aesthetic properties.[2]

Recent advancement in direct dental restorative materials is the incorporation of the nanotechnology which is understanding and control of matter at dimension of roughly 1 – 100 nm.[2]

Adequate finishing and polishing of resin composites is a prerequisite for high quality, esthetic and enhanced longevity of the resin – based restorations. Finishing refers to as the contouring of the cured

restoration where as polishing reduce the roughness produced by finishing instrument.[3]

Polishing is the process carried out after the finishing procedure to remove minute scratches from the surface of a restoration and to obtain a smooth, light reflective luster surface.[4]

A variety of instruments are commonly used for finishing and polishing tooth – colored restorative materials including: carbide finishing burs, 25 – 50 µm diamond finishing burs, abrasive impregnated rubber cups and points, aluminum oxide coated abrasive discs, abrasive strips and polishing pastes.[5]

Heraeus system (HER). Shofe system (SHO), (Sof – Lex) system, POGO polisher and others are different systems used for polishing finished composite resin.[3]
Sof – Lex system is a multi – step abrasive disks containing aluminum oxide abrasive, used for polishing composites, is the polishing system which is preferable, because it gives better results.[3,5]

Proper finishing and polishing for both anterior and posterior composite restoration are important step that enhance both esthetics and longevity of the restored teeth, surface roughness associated with improper finishing and polishing can result in excess surface staining, increased wear rates and plaque accumulation which compromised the clinical performance of the restoration.[6,7]

The aim of this study to evaluate the surface roughness for three different types of light activated composite resin using (Sof-Lex) – polishing system. (A profilometer study).

MATERIALS AND METHODS

The study was carried out in the Department of Conservative Dentistry, College of Dentistry, University of Mosul and Department of Mechanical Engineering, University of Salahaddin.

A total of 30 specimens (disk) (10mm) in diameter and (3 mm) in height were prepared from three different types of light activated composite resin, as shown in Table (1) and Figure (1), include 3 – groups. Group I: 10 specimens were prepared from light activated Nano hybride (Tetric n – Ceram, Ivoclar – Vivadent – Liechtenstein). Group II: 10 specimens were prepared from light activated microhybride composite resin (Arabesk – Voco, Germany). Group III: 10 specimens were prepared from light activated polyglas composite resin (Solitaire – 2, Heraeus, Kulzer, Germany).

Table (1): Composition of the three different types of light activated composite resin.

Composite resin	Composition	Particle size	Manufacture
Tetric n – Ceram	Dimethacrylates (19-20 wt%) barium glass, ytterbium trifluoride, mixed oxide, copolymers (80-81 wt%), catalyusts, stabilizers and pigments (< 1 wt%) inorganic filler 55 – 57 vol%	40 nm – 3000 nm	Ivoclar Vivadent
Arabesk	60% by volume (76.5% by weight) fillers,		Voco, Germany
	microfillers	0.05µm	
	small particle fillers	0.5 – 2 µm	
Solitarine 2	Multicross – linking urethane (meth) acrylatemonomers,	0.02 - 23 µm	Heraeus - kulzer
	BaAF – silicate glass, Porous silicon dioxide	ϕ 0.7 µm; max < 2µm	
		ϕ 8 µm; max < 23µm	

Figure (1): Light activated composite materials used in this study

The specimens of light activated composite resin were prepared using a Teflon mold. The mold had a central hole measuring (10 mm) in diameter and (3 mm) in height. The mold was inserted in a glass slide and filled with a composite resin using an incremental technique layer by layer with a plastic instrument, covered with Mylar strip and glass slide to produce a smooth surface and facilitate light curing.The specimens were cured with visible light curing ,"activation" was done with Blue-luxcer^{TM}-curing light (Model M855-Halogen lamp, Monitex Taiwan 08H0151) for 40 seconds, from top of the specimen .The mold through the glass slide was exposed to light from uper,lower,right,left cover stript sides. With light intensity of the curing unit was standardized to at least 500 nm (output) double the recommended time to ensure complete polymerization of the specimens which storage in distilled water.[3,5]

The resin blocks were finished to a uniform surface using carbide bur (Komet, UK) at medium speed for 10 seconds under water coolant for each of the surfaces to create base line finishing.

Finishing and Polishing procedure include using (Sof – Lex) polishing system which include using multi – step abrasive disc (Sof – Lex)^{TM} aluminum oxide disk (Sof – lex, 3M ESPE, Dental products, St. Paul, USA) used for polishing composite.

As we mentioned a number of finishing and polishing devices are available (Sof – lex, Heraeus, Shofer, PoGo system).[3,5] Sof – lex is a better finishing – polishing system then others its has become a standard frequently used in research trial because of a smooth surface commonly achieved without destroying the composite resin surface.[3,5] Thirty samples were polished with aluminum oxide abrasive disks in the kit were attached by a metal hub to the autoclavable metal mandrel as shown in Figure (2).

Figure (2): Aluminum oxide abrasive disks (Sof – les) and metal mandral

The coarse grit disk (brown in colour) was used for gross reduction at decrease speed of low speed motor hand piece, the medium grit disk (yellow in colour) was used for gross contouring at a decrease speed for 15 – 20 second. The fine grit disc (green in colour) followed by super-fine grit disc (blue in colour) was used to finish at increase speed of low speed motor hand piece for 15 – 20 seconds.[3,5]

After the samples were finished-polished, the samples were analyzed for surface roughness using a two dimensional surface profilmeter (Taylor – Hobson "Talysurf – 10" made in UK) as shown in Figure (3).

Figure (3): Profilometer used for measurement of surface roughness (Ra)

The roughness average (Ra) of the specimens was defined as the arithmetic average height of roughness component irregularities from the mean line measured with the sampling length.[3,5]

Profilmeter readings were made at the centre, right and left side of each specimen and the numerical average was determined for each group, it provided a quantative recording of the surface irregularities[3,5] as shown in Figure (4).

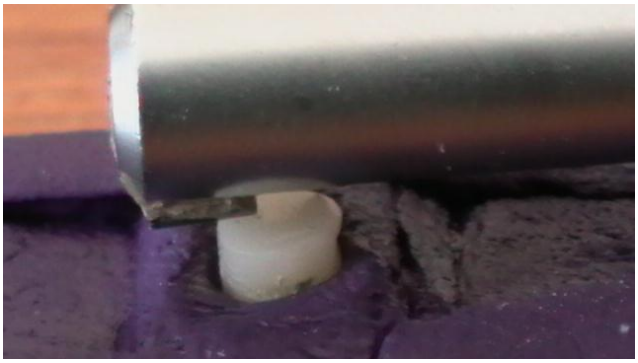

Figure (4): Evaluation of surface roughness (Ra) for the prepared specimen

The profilmeter produce a tracing using a digital and analogue hardware and software and calculates the average surface roughness (Ra) value for the resultant tracing.[3,5] Data were collected ANOVA and Duncan multiple range test was used for statistical analysis.

RESULTS

The results shown in Table (2). ANOVA and Duncan Multiple Range Test was applied to determine the significant differences in the surface roughness among different groups. *P*- value of 0.05 or less was considered as statistically significance.

Table (2): Roughness average (Ra) after using (Sof –Lex) polishimg system for three different types of composite resin.

Sample no.	Group I (Tetric n – Ceram)	Group II (Arabesk)	Group III (Solitaire- 2)
1	0.109	0.210	0.370
2	0.103	0.120	0.350
3	0.115	0.221	0.352
4	0.106	0.213	0.361
5	0.118	0.127	0.402
6	0.107	0.134	0.299
7	0.114	0.112	0.371
8	0.127	0.126	0.375
9	0.120	0.123	0.372
10	0.101	0.121	0.261

Profilometer provides a digital readout of the average surface roughness (Ra) in microns. The average roughness value represents the arithmetic mean of the height of all surface irregularities over a predetermined linear segment of each specimen.

Statistical analyses were performed for data using one way ANOVA and Duncan multiple range tests. The surface roughness average showed that there is statistically significant difference ($p< 0.05$) among three different types of light activated composite resin.

Tetric n – Ceram composite resin showed the lowest roughness average (0.112 µm) followed by Arabesk composite (0.150 µm), Solitaire – 2 composite resin showed the highest roughness average (0.341 µm) as shown (Table 3).

Table (3): ANOVA and Duncan's multiple range tests of the roughness average (Ra) for the 3 – different composite groups.

Composite resin	Mean (µm)	Standard deviation	*P* - value	Duncan's group
Tetric n – Ceram	0.112	0.008		A
Arabesk	0.150	0.044	$P < 0.05$	B
Solitaire 2	0.341	0.046		C

Different letters mean significant difference at $p\leq 0.05$

DISCUSSION

Composite restoration was finished and polished in order to establish a functional occlusal relationship and contour physiologically in harmony with supporting tissues, proper contour and high gloss give the restoration the appearance of natural tooth structure.[3,7]

Resin – based composites resins can't be finished to an absolutely smooth surface, as it is essential requiste for a successful restoration. The finishing and polishing procedures directly influence the longevity of the restoration and its environment.[3,7]

The final polish obtained on a composite restoration would be determined by two factors: composition of the composite with relation to the matrix, size of filler particles and the type of polishing system used. The degree of polymerization of the matrix, the size, composition and volume of the filler particles affect the surface finish obtained on the composites which are the resin matrix and filler particles don't abrade to the same degree.[8]

The larger the filler particles, the rougher the surface would be after polishing.[3,9]

For resin composite restoration polymerized under a matrix strip, they tend to exhibit the smoothest surface, but the marginal area would still require finishing and polishing.[10-12]

Several investigations have shown that removal of the polymer – rich outer most resin layer is essential to achieving a stain

resistant, more esthetically stable surface.[9,13,14]

In this study, there is significant difference in the surface roughness after using Sof – Lex polishing systems among 3 – different types of light activated composite resin at level of significance ($p< 0.05$). The lowest roughness average was recorded in specimens prepared from Tetric – n Ceram composite resin (0.112) because the particle size of inorganic filler in composite resin are so small that their stiffness is reduced and so their malleability promotes a homogenous abrasion of the fillers and the resin matrix.[5,15-17]

Also in this study, Arabesk (microhybride composite) showed roughness average (0.150) higher than that of Tetric – n Ceram , this could be in-Tetric-n ceram the particle size of the inorganic filler incomposite resin are so small (nano-hybride). Arabesk can be finished and polished to a smooth surface, and it is distinguished by its high level of colour stability.[11,12,18]

Toledano *et al*[19] evaluated surface roughness for resin composites after using two polishing methods, they concluded that microfill and microhybride composites can be finished to a very smooth surfaces with a surface roughness average (Ra) varying from 0.12 to 0.25 µm due to their small filler particle size and arrangement. The size of microfill composite filler is 0.04 µm and a microhybride contains particles that range between 0.01 and 2.0 µm, therefore, they can finished to a smoother surface than that of packable (Solitaire -2) composites evaluated in their study.[19]

The highest roughness average were recorded for Solitaire – 2 composite (0.341) in comparison with others (Tetric n – Ceram, Arabesk), as we mentioned above that the larger the filler particles the rougher the surface would be after polishing.[3,9,20]

Adequate finishing and polishing of composite resin is a prerequisite for high quality, esthetic and enhanced longevity of the resin based restoration.[3]

Surface roughness associated with improper finishing and polishing can resulted in excess surface staining increase wear rates and plaque accumulation which compromised the clinical performance of the restoration. [6,7]

CONCLUSIONS

The Tetric n- ceram that has particles size of inorganic filler in composite resin are so small. They give the best polished surface and a lowest roughness average. In comparison with others (Arabesk, Solitare, 2). (Sof-lex)^{TM} polishing system give better results, a smooth surface commonly achieved without destroying the composite resin surface.

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