

Evaluation The Surface Roughness of New Composite Materials After Using Different Polishing Methods

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Abstract: *Background:* Prophylaxis methods are used to mechanically remove plaque and stain from tooth surfaces; such methods give rise to loss of superficial structure and roughen the surface of composites as a result of their abrasive action. This study was done to assess the effect of three polishing systems on surface texture of new anterior composites after storage in artificial saliva.

Materials and methods: Twenty samples of Giomer and twenty samples of B 90 (3M ESPE) composite discs of 12 mm internal diameter and 3mm height were prepared using a specially designed cylindrical mold and were stored in artificial saliva for one

month and then the samples were divided into four groups according to surface treatment:

Group A (control group): *10 specimens received no surface polish and were subdivided into 5 samples of A1 Giomer and 5 samples of A2 B 90 composite.*

Group B: *10 specimens received polishing with Air polishing devise (APD) and were subdivided into 5 samples of B1 Giomer and 5 samples of B2 B 90 composite.*

Group C: *10 specimens received polishing with pumice and brush and were subdivided into 5 samples of C1 Giomer and 5 samples of C2 B 90 composite.*

Group D: *10 specimens were polished with pumice and rubber cup and were subdivided into 5 samples of D1 Giomer and 5 samples of D2 B 90 composite.*

Testing was done by means of profilometer and statistically analyzed using analysis of variance (ANOVA) test, LSD and student t-test.

Results: *The results showed a highly statistical significant difference in surface roughness among Giomer subgroups $P < 0.05$. Also there was a highly significant difference ($P < 0.05$) among B 90 subgroups according to the type of surface treatment.*

Furthermore there was non-significant difference $P>0.05$ between groups according to the type of restorative material used.

Conclusion: *The use of prophylactic surface treatment significantly increased Giomer and B 90 surface roughness and the use of rotating brush has shown the roughest surface among all other types of prophylactic protocols also Giomer had shown more surface roughness than B 90 although the difference was not significant.*

Key words: *Surface roughness, fluoride.*

Introduction

The last decade has witnessed significant improvements in the physical and mechanical properties, esthetics, and durability of resin composite materials for direct restorations [1].

One feature that has enhanced resin-based restorative materials is fluoride release; several fluoride containing materials have been developed, such as resin-modified glass ionomer, compomer, giomer and fluoride-containing resin-based composite.

Giomer has been introduced for cervical restorations, these light-cured materials incorporate glass-ionomer fillers into the resin matrix. Giomers bear the advantages of both composite resins and glass-ionomers; they have excellent esthetics, good polishability, and biocompatibility and also render glass-ionomer properties, including fluoride release and fluoride recharge potential [2]. Proper seal against bacterial microleakage and minimal mechanical and chemical irritation of the pulp are other advantages of giomers [3].

Long-term clinical studies have reported satisfactory visual texture and surface roughness of Giomer restorations. There is a

little information available about the influence of prophylaxis procedures on Gioners [4].

Prophylaxis methods are aimed at mechanical removal of stains and plaque from tooth surfaces, especially in the vicinity of gingival tissues. These methods are factors involved in damaging and even destroying the surface of cervical restorations [5].

The use of pumice and rubber cup is the most common method to remove plaque and stains. Recently, the use of air-powder polishing device (APD) has gained popularity among dentists [6]. In previous studies influence of different prophylaxis procedures on surface roughness of different types of composite resins and glass-ionomers has been investigated and it has been reported that the effect of prophylaxis treatments depends on the material [7].

The purpose of this in vitro study is to determine the influence of three types of polishing systems on the surface roughness and surface morphology of new fluoride releasing aesthetic material known as Giomer and B 90 3M composite after one month storage in artificial saliva.

Materials and methods

Twenty specimens of Giomer shade A3 (Shofu, Kyoto, Japan) and twenty samples of B 90 composite shade A3 (3M ESPE) composite discs of 12 mm internal diameter and 3mm height were prepared using a specially designed cylindrical mold [8].

The composite were inserted and pressed into the mold until they were overfilled, the material then were covered with a transparent matrix strip and glass microscopic slide to extrude excess material and flatten the surface and to reduce voids at the surface. Specimens were then polymerized according to manufacturers' instructions with a conventional quartz halogen light-curing unit (YDL, Hangzhou Yinya New Materials CO., China). Then all specimens were stored in artificial saliva in a constant temperature incubator (Mettmert, Germany) at 37 C° for one month [9].

The twenty specimens of Giomer were divided into four groups (A, B, C and D). Also the twenty specimens of B 90 were divided

into 4 groups (A, B, C, and D). After that each of these main groups were further subdivided into two subgroups (A1, A2, B1, B2, C1, C2, D1, D2) five for each type of composite (giomer and B 90).

For Group A (control group), no surface treatment was applied, for group B the surface was treated with an air-powder polishing device (Air-flow handy SMS DENT, Malaysia). The alignment of the tip was perpendicular to surface for 12 seconds and 10 mm distance. In group C a rotating brush (TPC Industry, USA) with pumice was used for 12 seconds using contra-angle handpiece (HK, ROC) at 2000 rpm. In group D the same procedure was applied but instead we used a rubber cub (Products CO, China) for the same period of time [10].

In groups B, C and D subsequent to the prophylaxis procedures, the samples were rinsed with deionized distilled water for 10 minutes to clean the sample surface from powder remnants.

After rinsing, the average value of surface roughness of all specimens were measured by means of profilometer (Talysurf 4, Taylor Hobson, UK) horizontal magnification= 4X, Vertical magnification= 500X to measure the roughness (Ra) on composite surface The profilometer measured each specimen at 3 areas in various locations with a maximum travelling distance of 11 mm. The average value was recorded. Samples were photographed by special orthoplane camera using light polarizing microscope to evaluate the surface alteration before and after prophylactic procedures using magnification power of 50X.

Results

The mean, standard deviation and standard error of surface roughness in μm with minimum and maximum value of each group are illustrated in table (1) and fig. (1)

Subgroup C1 (brush group) showed the highest mean of surface roughness (1.78 ± 0.148) while subgroup A2 (control group) showed the lowest mean of surface roughness (1.1 ± 0.245).

The statistical analysis of data using ANOVA test revealed that there was a highly significant difference among Giomer subgroups (A1 control, B1 APD, C1 brush and D1 rubber cub) $P < 0.05$ table

(2). Also there was a highly significant difference when comparing B 90 subgroups (A2 control, B2 APD, C2 brush and D2 rubber cup) $P < 0.05$ table (4).

The source of differences was further investigated using LSD test. These investigations had shown that there was a significant difference among all giomer subgroups except for subgroups (A1 control, D1 rubber cup), and (B1 APD, C1 brush) which had shown a non-statistical significant difference ($P > 0.05$) in mean surface roughness according to the method of surface treatment table (3).

Also the results using LSD has shown a significant difference ($P < 0.05$) in mean surface roughness between B 90 subgroups except between (B2 APD, C2 brush) and between (C2 brush and D2 rubber cup) subgroups which had shown a non-significant difference $P > 0.05$ table (5).

Further analysis between subgroups of the same group according to the type of restorative material using t-test was needed to show where the significance had occurred between Giomer and B 90 subgroups, table (6).

Analysis by t-test had shown a non-significant difference $P > 0.05$ in mean surface roughness between all the mentioned subgroups.

Discussion

The quality of surface is an important parameter that influences the behavior of dental restorations in the oral environment in different ways. Hygiene maintenance therapy is an integral part of restorative and periodontal treatment. The removal of stains and plaque from all accessible tooth surfaces is a routine part of the maintenance appointment [11].

The conventional rubber cup prophylaxis and air-powder polishing system are both effective professional techniques for plaque and stain removal. Since its introduction to the dental marketplace in 1977, air-powder polishing systems have been effective at removing stains and plaque, previous studies on various types of composite resins and glass-ionomer have reported that the

air-powder polishing device produces a rougher surface compared to the pumice and rubber cup technique [12].

The surface roughness (Ra) refers to fine irregularities of the surface texture that usually result from the action of the production process or material conditions and is measured in micrometers (μm). This parameter describes the overall roughness of the surface and can be defined as the arithmetic average value of all absolute distances of the roughness profile from the center line within the measuring length.

The roughness parameters are dependent on several factors such as filler size, percentage of surface area occupied by filler particles, hardness, degree of conversion of polymer to resin matrix and filler/matrix interaction, as well as stability of silane coupling agent [13].

The results of the present study indicated that prophylaxis treatments of Giomer and B 90 subgroups resulted in a highly significant increase in surface roughness in comparison with the control group for both restorative materials. Pumice with brush group showed a dramatic increase in surface roughness followed by air-powder polishing device, and pumice with rubber cup.

These results agree with previous studies on Giomer in which there were significant increases in surface roughness between groups treated by prophylactic systems [14]. The higher surface roughness values in the pumice-with brush group might be attributed to the abrasive feature of rotating brush [15].

In the present study, the use of air-powder polishing device resulted in increase in surface roughness when compared to the use of rubber cup in Giomer and B 90 samples, which confirms the results of previous studies conducted on composite resins and glass-ionomer. It seems that high pressure of air and water in air-powder polishing device is strong enough to degrade the filler-resin bond joined together through silane. Therefore, the fillers from the superficial layer are deboned. Furthermore, the possibility of the abrasion of filler phase of resin materials by powder components of APD has been reported [16].

The results of the present study showed that surface roughness in all the Giomer groups was non significantly higher than that in the corresponding composite resin groups. Differences in surface roughness between B 90 and Giomer might be attributed to different chemical compositions of the two materials. Previous studies have demonstrated the effect of chemical composition of materials on surface roughness. It has been reported that Giomer releases more fluoride compared to composite resin because it contains fluoridated glass fillers with glass-ionomer matrix. This matrix has a high content of fluoride complex, and water easily penetrates into it, which results in the release of large quantities of fluoride and this will increase porosity and surface roughness. Previous studies have reported greater fluoride release from giomers in comparison to B 90 composite [17].

The specimens in the present study were placed in artificial saliva for one month and any loose filler particles from polished composite surface present were probably dislodged forming voids and individual glass particles protruding, so stresses could build up in the glass particles-resin matrix interfaces, and early immersion into artificial saliva may help to propagate the cracks.

It has been shown that the introduction of finer particles among larger ones will result in reduction of inter-particle spacing and the amount of resin matrix, thus maximizing the overall properties of the material. Decreased inter-particle spacing caused by reduced filler size may leads to reduction in strain localization around the filler, thus reducing the fatigue failure. The concept of multimodal fillers enables the composites to obtain high filler loading and allows a strong integration of small particles into resin matrix that can be eroded by breaking off small individual particles rather than large ones [18].

Based on the methodology used in this study we could conclude that the use of different prophylaxis methods resulted in a significant increase in surface roughness for both restorative materials and the roughest surface was created with APD. Compared to untreated (control) group the surface roughness of the Giomer and B 90 specimens treated with all prophylaxis methods

were greater than 0.2 μm , which is a threshold value for bacterial adherence.

Conclusion

Re-polishing of Giomer and B 90 composite restorations subsequent to the prophylaxis treatments tested might be necessary.

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Table (1) Descriptive statistics of the surface roughness values in μm for all groups

Groups	N	Mean	SD	SE	Min.	Max.
A1	5	1.24	0.181	0.081	1	1.5
A2	5	1.1	0.254	0.114	0.9	1.5
B1	5	1.74	0.313	0.140	1.2	2
B2	5	1.64	0.114	0.051	1.5	1.8
C1	5	1.78	0.148	0.066	1.6	2
C2	5	1.6	0.234	0.105	1.4	1.9
D1	5	1.48	0.164	0.073	1.2	1.6
D2	5	1.32	0.130	0.058	1.2	1.5
Total	40					

Table (2) ANOVA test comparison among subgroups with different surface treatment using Giomer

Studied groups	N	Mean	SD	df	F	P-value	Sig.
A1	5	1.24	0.182	2	9.192	0.001	HS
B1	5	1.74	0.313				
C1	5	1.78	0.148				
D1	5	1.48	0.310				
Total	20						

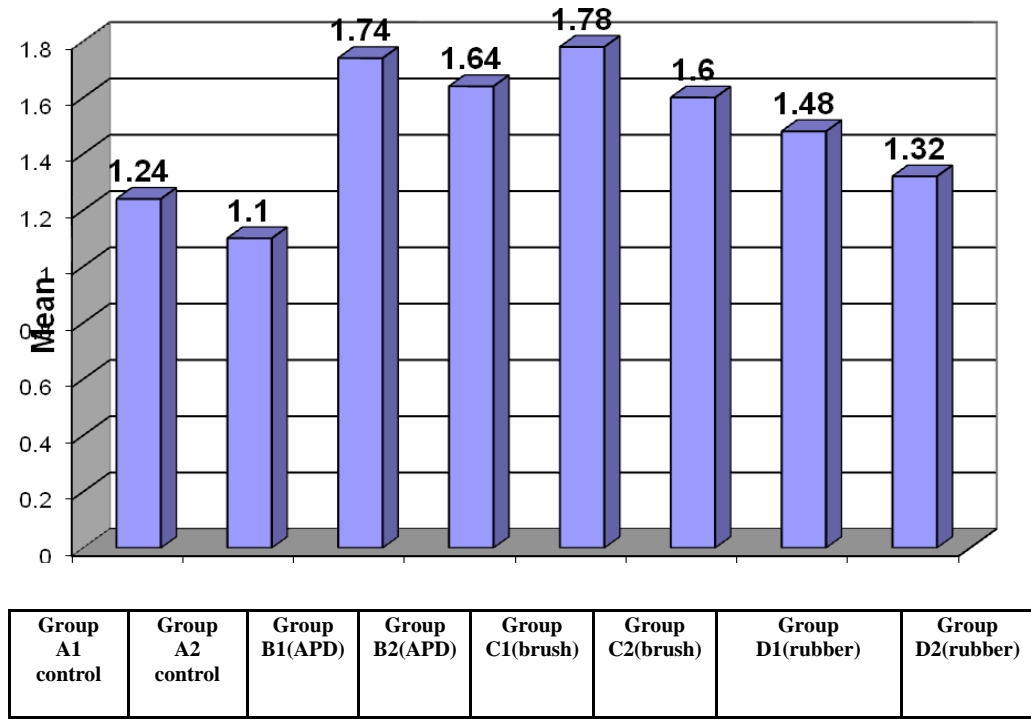


Figure (1) Bar chart showing means value of surface roughness values in μm for all groups

Table (3) The least significant difference (LSD) of multiple comparison test for Giomer studied subgroups according to surface treatment.

Studied groups		LSD (f-test)	
		P-value	Sig.
A1	B1	0.001	HS
A1	C1	0.001	HS
A1	D1	0.5	NS
B1	C1	0.76	NS
B1	D1	0.05	S
C1	D1	0.03	S

Table (4) ANOVA test comparison among subgroups with different surface treatment using B 90 composite.

Studied groups	N	Mean	SD	df	F	P-value	Sig.
A2	5	1.1	0.25	2	9.542	0.0017	HS
B2	5	1.64	0.11				
C2	5	1.6	0.23				
D2	5	1.32	0.13				
Total	20						

Table (5) The least significant difference (LSD) of multiple comparison test for B 90 studied subgroups according to surface treatment

Studied groups		LSD (f-test)	
		P-value	Sig.
A2	B2	0.026	S
A2	C2	0.033	S
A2	D2	0.031	S
B2	C2	0.621	NS
B2	D2	0.049	S
C2	D2	0.342	NS

Table (6) t-test of multiple comparison test according to the type of restorative material.

Studied groups		t-test	
		P-value	Sig.
A1	A2	0.758	NS
B1	B2	0.427	NS
C1	C2	0.532	NS
D1	D2	0.256	NS

تقييم خشونة سطح حشوات الراتنج الحديثة بعد صقلها بطرق مختلفة

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المستخلص:

ان الطرق الوقائية المستعملة في تنظيف الاسنان تقوم برفع البلاك والبقع من سطح الاسنان بطرق ميكانيكية ، لذا فإن هذه الطرق تقوم بقشط الطبقة السطحية من حشوة الراتنج وتؤدي الى خشونتها .اجريت هذه الدراسة لتقييم تأثير ثلاث طرق تنعيم وصقل على طبيعة سطح انواع حديثة من حشوات الراتنج ومن ثم خزنها في مادة لعابية صناعية.

استعمل في هذه الدراسة 40 نموذج 20 منها من مادة الجيومر (شوبا كيبوتو ، يابان) وعشرون منها من مادة ب 90 (3 ام اس بي) على شكل اقراص بقطر 12 ملم وارتفاع 3 ملم تم خزنها في لعاب صناعي لمدة شهر وبعدها قسمة الى اربع مجاميع بالاعتماد على طريقة معالجة السطح :

المجموعة الاولى : 10 نماذج 5 منها من الجيومر وخمسة منها من ب 90 بدون معالجة سطحية .

المجموعة الثانية : 10 نماذج 5 منها من الجيومر و5 منها من ب 90 تم صقلهم بجهاز ضخ الهواء .

المجموعة الثالثة : 10 نماذج 5 منها من الجيومر و5 من ب 90 تم صقلهم باستخدام البولش والفرشاة .

المجموعة الرابعة : 10 نماذج 5 منها من الجيومر و5 من ب 90 تم صقلهم باستخدام البولش والمطاط .

اختبار سطح السن تم بواسطة جهاز البروفايلوميتر . النتائج التي تم الحصول عليها حلت باستخدام تحليل التباين واختبار الاقل فرق معنوي .

اظهرت النتائج ان هنالك فرق احصائي معنوي عالي بين مجاميع الجيومر وايضا" بين مجاميع ب 90 ، بينما لا يوجد فرق احصائي ملحوظ بين المجاميع بالنسبة لنوع الراتنج المستعمل . نستنتج من هذه الدراسة ان طرق الوقاية المستعملة تؤدي الى زيادة معنوية في خشونة سطح حشوات الجيومر وب 90 الراتنجيات وان استعمال الفرشات الدورانية يؤدي الى اعلى خشونة سطح وان حشوات الجيومر تكون اكثر خشونة من ب 90 الراتنجية ولكن الفرق الاحصائي غير معنوي .

الكلمات الرئيسية : خشونة السطح ، الفلورايد