

# The surface roughness of new fluoride releasing material after using three polishing protocols and storage in artificial saliva

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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:** A total of 40 Giomer and Tetric®N-Ceram 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 samples were divided into four groups according to surface treatment:

Group A (control group): 10 specimens received no surface polish and were subdivided into A1 (Giomer) and A2 (Tetric®N-Ceram). Group B: 10 specimens received polishing with Air polishing device (APD) and were subdivided into B1 (Giomer) and B2 (Tetric®N-Ceram). Group C: 10 specimens received polishing with pumice and brush and were subdivided into C1 (Giomer) and C2 (Tetric®N-Ceram). Group D: 10 specimens were polished with pumice and rubber cup and were subdivided into D1 (Giomer) and D2 (Tetric®N-Ceram). Testing was done by means of profilometer and statistically analyzed using analysis of variance test (ANOVA), LSD and student t-test. Also samples were photographed by special orthoplane camera using light polarizing microscope.

**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  $P < 0.05$  when comparing Tetric subgroups according to 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 Tetric ceram 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 Tetric ceram although the difference was not significant.

**Key words:** Surface roughness, fluoride, artificial saliva. (J Bagh Coll Dentistry 2013; 25(1):21-26).

## INTRODUCTION

The last decade has witnessed significant improvements in the physical and mechanical properties, esthetics, and durability of resin composite materials for direct restorations <sup>(1)</sup>.

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.

Giomers 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 <sup>(2)</sup>. Proper seal against bacterial microleakage and minimal mechanical and chemical irritation of the pulp are other advantages of giomers <sup>(3)</sup>.

Long-term clinical studies have reported satisfactory visual texture and surface roughness of giomer restorations. There is little information available about the influence of prophylaxis procedures on giomers <sup>(4)</sup>.

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 <sup>(5)</sup>.

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 <sup>(6)</sup>. 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 <sup>(7)</sup>.

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 nano hybrid composite Tetric N ceram after one month storage in artificial saliva.

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## MATERIALS AND METHODS

Forty specimens of giomer A3 (Shofu, Kyoto, Japan) and tetric N ceram shade A3 (Ivoclar vivvudent) composite discs of 12 mm internal diameter and 3mm height were prepared using a specially designed cylindrical mold<sup>(8)</sup>.

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 (Memmert, Germany) at 37 C° for one month<sup>(9)</sup>.

The forty specimens were divided into four groups (A, B, C and D) and each of these main groups was further subdivided into two subgroups five for each type of composite (giomer and tetric N ceram).

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 cup ( Products CO, China) for the same period of time.<sup>(10)</sup>

In groups B, C and D subsequent to the prophylaxis procedures the samples were rinsed with deionized distilled water for 10 minutes.

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  $\mu\text{m}$  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 ( $1.78 \pm 0.148$ ) while subgroup A2 (control group) showed the lowest mean of surface roughness ( $1.1 \pm 0.245$ ).

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 cup)  $P < 0.05$  (table 2). Also there was a highly significant difference when comparing Tetric 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). By the use of LSD there was a significant difference ( $P < 0.05$ ) in mean surface roughness between Tetric ceram 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 Tetric 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<sup>(11)</sup>.

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 APD produces a rougher surface

compared to the pumice and rubber cup technique<sup>(12)</sup>.

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 ( $\mu\text{m}$ ). 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<sup>(13)</sup>.

Tetric N ceram composite resin and a giomer were chosen to be used in this study because these aesthetic restorative materials are commonly used in cervical areas, in variably more susceptible to the action of prophylactic treatments.

The results of the present study indicated that prophylaxis treatments of giomer and tetric 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 APD, and pumice with rubber cup.

These results agree with previous studies on giomer in which there were a significant increase in surface roughness between groups treated by prophylactic systems<sup>(14)</sup>. The higher surface roughness values in the pumice-with brush group might be attributed to the abrasive feature of rotating brush<sup>(15)</sup>.

In the present study, the use of APD resulted in increase in roughness when compared to the use of rubber cup in giomer and tetric 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 APD is strong enough to degrade the filler-resin bond joined together through silane. Therefore, the fillers from the superficial layer are debonded. Furthermore, the possibility of the abrasion of filler phase of resin materials by powder components of APD has been reported<sup>(16)</sup>.

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 tetric ceram 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 lead to increase porosity and surface roughness. Previous studies have reported greater fluoride release from gomers in comparison to Tetric N ceram<sup>(17)</sup>.

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.

Tetric resin composite contains 3 fillers, which are 0.02  $\mu\text{m}$  nanofiller, 0.04  $\mu\text{m}$  barium glass filler and pre-polymerized filler (PPF). This system is named trimodal nano-filler technology. Tetric exhibited a low roughness value after applying the prophylactic paste and showed better results than giomer, which may be a result of this new trimodal system. Our results support the claim of the manufacturer, that Tetric N ceram is designed to offer high polishability.

It has been shown that the introduction of finer particles among larger ones will result in reduction of interparticle spacing and the amount of resin matrix, thus maximizing the overall properties of the material. Decreased interparticle 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<sup>(18)</sup>.

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 tetric ceram specimens treated with all prophylaxis methods were greater than 0.2  $\mu\text{m}$ , which is a threshold value for bacterial adherence. Therefore, re-polishing of giomer and tetric ceram restorations subsequent to the prophylaxis treatments tested might be necessary. Given the results of the current study, further investigations

on the surface roughness and abrasion resistance of giomer restorative materials are warranted.

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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
<b>Total</b>	<b>40</b>					

**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				
<b>Total</b>	<b>20</b>						

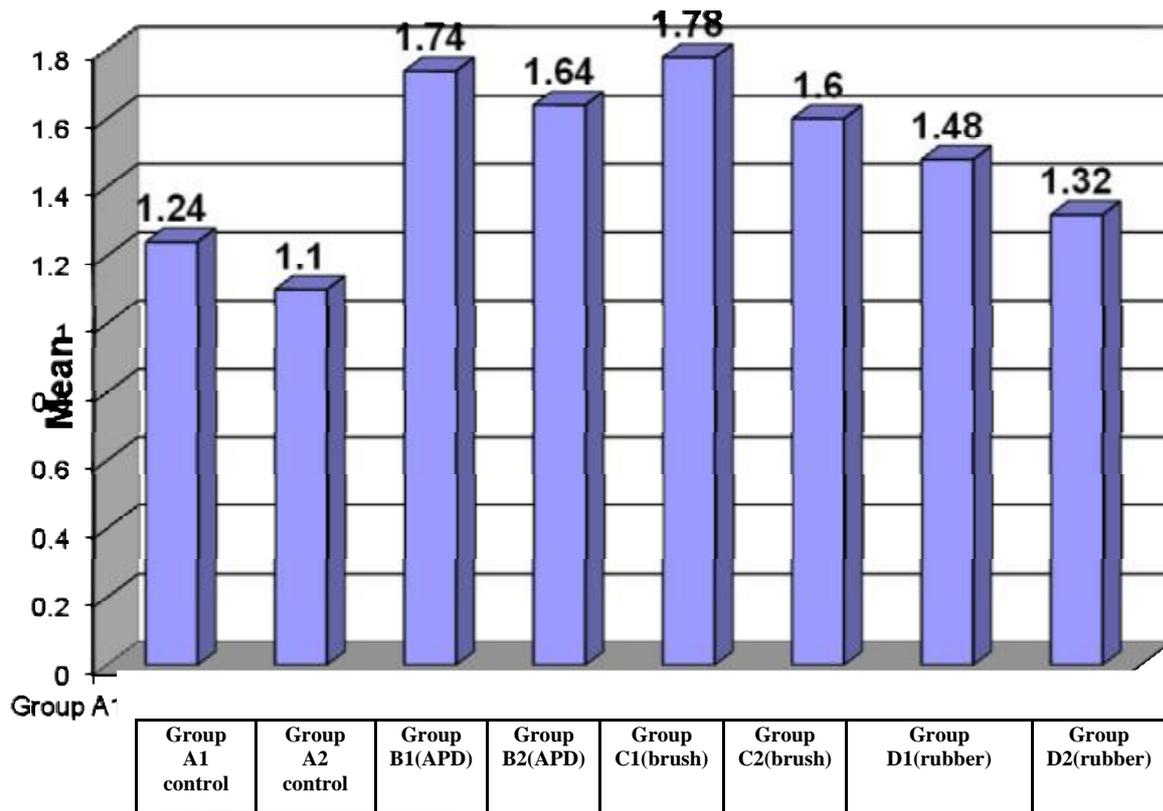


Figure 1: Bar chart showing means value of surface roughness values in  $\mu\text{m}$  for all groups

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 Tetric ceram

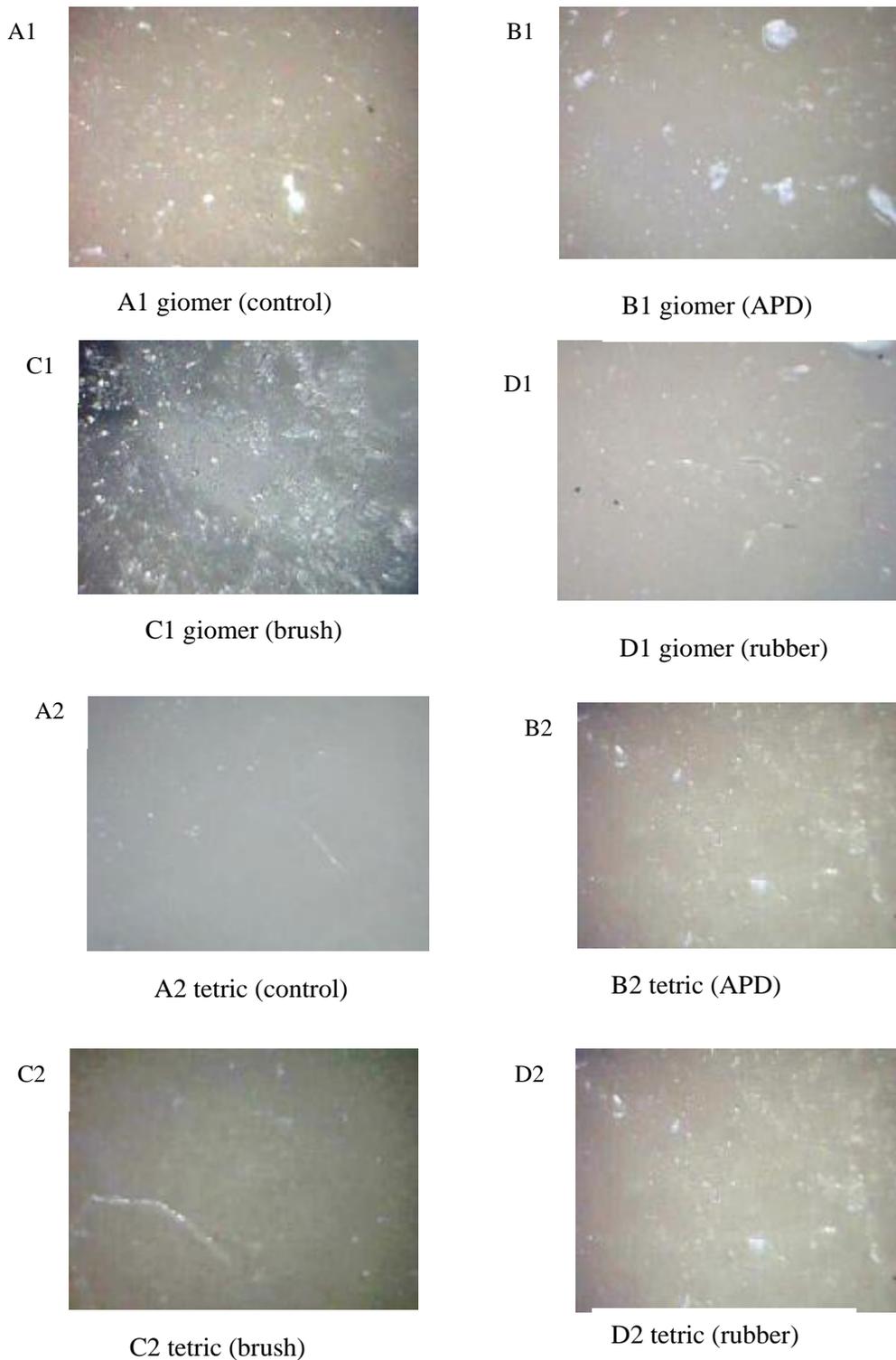
Studied groups	N	Mean	SD	df	F	P-value	Sig.
A2	5	1.1	0.25	2	9.542	0.0017	HS
B2	5	1.64	0.11				
C2	5	1.6	0.23				
D2	5	1.32	0.13				
Total	20						

Table 5: The least significant difference (LSD) of multiple comparison test for Tetric ceram 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



**Figure 2: Polarized light microscope figures after surface treatment of giomer and tetric ceram**