In Vitro Evaluation Of Surface Roughness Of Three Class V Restorative Materials Following Prophylactic Instrumentation

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Abstract
Objective*: This study was designed to determine which among the three Class V restorative materials - Omnichroma, GC Gold label Hybrid and Beautifil exhibits the least increase in surface roughness when subjected to manual or ultrasonic prophylactic instrumentation.*
Materials and methods*: Class V cavity preparation were performed on 60 mandibular premolar teeth and randomly divided into 3 groups of 20 specimens each. They were restored with the assigned restorative material, i.e. Composite (Group 1), GIC (Group 2) and Giomer (Group 3). Restorations were finished and polished and then subjected to surface profilometry analysis for determining the surface roughness values followed by simulated aging by thermocycling. These groups were further subdivided into two subgroups consisting of 10 samples each and subjected to manual and ultrasonic prophylactic instrumentation followed by surface profilometric analysis. After polishing using prophylactic paste, once again surface profilometry analysis was done. The data thus obtained were subjected to statistical analysis using SPSS 26.0 (SPSS Inc., Chicago, IL) software.*
Results and discussion*: The highest value for surface roughness was seen with Group 1 (Omnichroma) followed by Group 2 (GC Gold Label hybrid). Group 3 (Beautifil) exhibited lowest value for surface roughness along all the stages. Manual instrumentation groups showed increased surface roughness compared to ultrasonic instrumentation groups.*
Conclusion*: Among the three tested materials, best surface finish at all stages of evaluation was seen with Beautifil, followed by GC Gold label hybrid and the lowest quality was seen with Omnichroma.*
Keywords: *Class V, Surface roughness, Profilometry, Thermocycling, Prophylactic instrumentation, Polishing.*

I.   Introduction

Restoration of cervical defects is one of the most commonly performed procedures in restorative practice[1]. The most commonly used materials to restore cervical lesions include conventional glass ionomer cements, composite resins and their combinations[2]. As calculus and plaque deposits are often heaviest in the cervical area of teeth, restorations of Class V cavities are inadvertently exposed to maintenance procedures, including but not limited to scaling either with hand or machine driven instruments[3]. Inarguating cervical areas are more vulnerable to the effect of prophylactic instrumentation. The extent to which the surface of various restorative materials undergoes degradation or sustained damage during prophylaxis depends upon various factors like operator expertise, type of instrumentation technique and instrument used[4]. The effect of periodontal instrumentation on the surface roughness of these restorative materials must be taken into consideration, since

these procedures might produce scratches, nicks, and chips on the tooth and also the restorations, which may roughen the tooth as well as restorations[2]. The presence of irregularities on the surface of the restorations may result in plaque and stain retention which may lead to gingival inflammation[4]. This may result in a self-perpetuating cycle of disease and restoration degradation. Therefore, the ability of the restoration material to withstand such instrumentation with little or no surface changes is desirable.

The present study was aimed at determining which among three class V restorative materials Composite (Omnichroma), Glass ionomer Cement (GC Gold label Hybrid) and Giomer (Beautifil) could best withstand without loss of surface finish when subjected to prophylactic instrumentation procedures.

II.   Materials And Methods

60 Human Mandibular Premolars extracted for orthodontic purpose were collected and embedded in putty impression material upto the level of the cementoenamel junction. Class V cavity preparation (4 mm × 2 mm × 1.5 mm) was carried out using No 41 Round and No 12 TF diamond coated abrasives in a high speed airotor under air water spray. Specimens were then randomly divided into 3 groups of 20 specimens each and were restored with the respective material – Composite, GIC or Giomer, manipulated as per manufacturer's instructions. Group 1 - Tokuyama Omnichroma (OM, Tokuyama Corp, Chiyoda City, Tokyo, Japan). Group 2 - GC Gold label Hybrid (India). Group 3 - Shofu Beautifill II (Shofu Inc, Kyoto, Japan). The restorations were then subjected to finishing and polishing using Super Snap Polishing kit (Shofu Inc, Kyoto, Japan).Thereafter they were subjected to surface profilometry analysis for determining the surface roughness values.

Surface Roughness assessment

Surface Roughness assessment was carried out Using 3D Non contact Surface Profilometer (Alicona Infinite Focus G5) followed by aging by thermocycling.
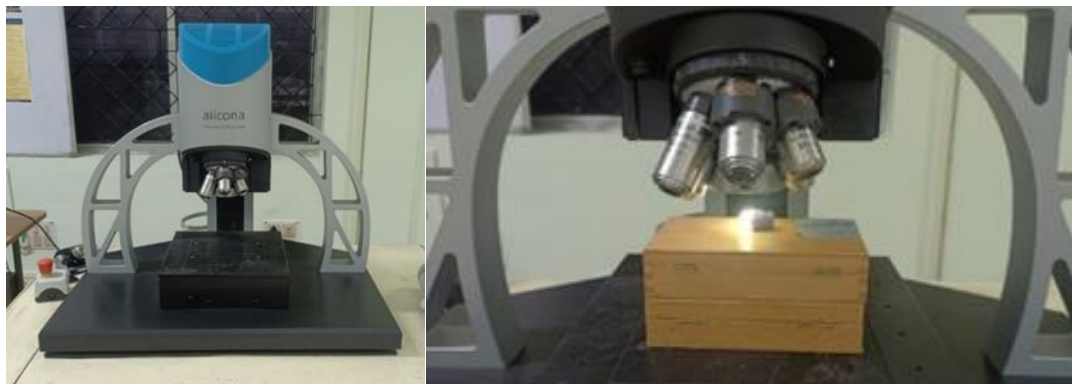

Fig 1. A - 3D Non-Contact Surface Profilometer (Alicona Infinite Focus G5),
B- Surface Profilometric Analysis.

Age assessment - Thermocycling

Thermocycling was done manually following the recommendation of the ISO/TS 11405, between –5 and 55°C water baths with a dwell time of 30 seconds for 250 number of cycles. The specimens were then subjected to Surface profilometry. The specimens in all three groups were further subdivided into two subgroups, each consisting of 10 samples. The specimens in subgroups 1A, 2 A and 3 A were subjected to manual prophylactic instrumentation and those in the B subgroups were subjected to ultrasonic prophylactic instrumentation.

Prophylactic instrumentation

Manual instrumentation was carried out using Gracey's curette - 5#6 (Hu-Friedy, Chicago).The curette blade was kept approximated with restoration surface making an arbitrary angle of 45°–60° with the restored surface. The blade was then moved from cervical to incisal direction while engaging it against the surface.A total of 20 strokes in a time span of 15 seconds was made for each specimen. Ultrasonic scaling was carried out using piezoelectric ultrasonic scaler having GD3 insert/tip under copious water flow for 15 seconds at a power setting of 5 W and frequency of 28 kHz. The scaling tip was angled as close to 0° to the restoration surface.The direction of scaling was maintained perpendicular to the long axis of the tooth in the horizontal plane while moving the scaler insert slowly from gingival to coronal third of the restoration. All specimens were once again subjected to surface profilometry. Afterwards, using Prophylactic paste – Proxyt (Ivoclar Vivadent, Schaan, Liechenstein) and rubber cups, polishing of all the specimens were carried out. This was followed by surface profilometric analysis.

Data was analyzed using the statistical package **SPSS 26.0** (SPSS Inc., Chicago, IL) and level of significance was set at **p<0.05**. Descriptive statistics was performed to assess the mean and standard deviation of

the respective groups. As the data was seen to follow normal distribution, the parametric tests One way ANOVA, Bonferroni post hoc and Independent t test were employed to compare within and across the groups.

III. Results

The results showed the highest value for surface roughness for Group 1 (Omnichroma) followed by Group 2 (GC Gold Label hybrid). Group 3 (Beautifil) had the lowest value for surface roughness, when measured immediately after placement, finishing and polishing. This trend was seen to be maintained in the profilometric analysis at each stage (after thermocycling, after prophylaxis and after final polishing), with the highest values for Group 1 and lowest for Group 3.oma) followed by Group 2 (GC Gold Label hybrid). When the surface roughness values were compared between manual and ultrasonic prophylactic instrumentation, it was seen that roughness values were greater after manual prophylactic instrumentation than ultrasonic prophylactic instrumentation in all groups. Another interesting observation was that the surface roughness after final polishing with prophylactic paste following prophylactic instrumentation was higher than before polishing, in all groups.

Groups		Initialgroups	Thermocycling	Manual	Ultrasonic	Post Prophylaxis-Manual	Post Prophylaxis - Ultrasonic	P Value
Omni Chroma (1)		1.53±0.05	1.65±0.05	1.74±0.05	1.69±0.06	1.81±0.01	1.76±0.02	1
Gc Gold Label Hybrid (2)		1.26±0.03	1.32±0.09	1.57±0.13	1.39±0.01	1.69±0.01	1.48±0.02	1
Beautifil (3)		1.20±0.03	1.23±0.09	1.40±0.03	1.32±0.01	1.48±0.04	1.40±0.04	1
P Value (One Way Anova Test)		0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	
P Value (Bonferroni) Posthoc Test)	1 Vs 2	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*		
	1 Vs 3	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*		
	2 Vs 3	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*		

Table 1. Mean and standard deviation of surface roughness (Ra) of all the materials
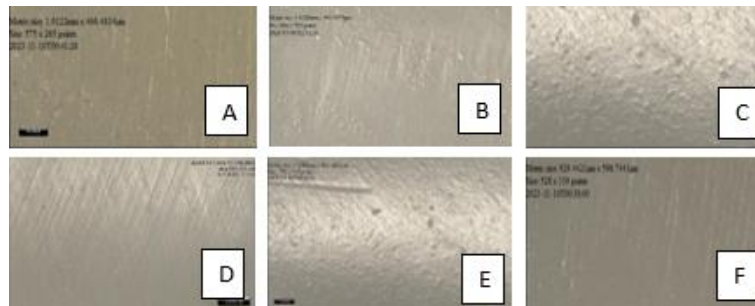

Fig 2. Surface Profilometric Images Of Group 1 – Omnichroma : A- After Initial Finishing And Polishing, B – After Thermocycling, C – After Manual Instrumentation, D – After Ultrasonic Instrumentation, E – Post Prophylactic Polishing(Manual Instrumentation Group) And F - Post Prophylactic Polishing(Ultrasonic Instrumentation Group)
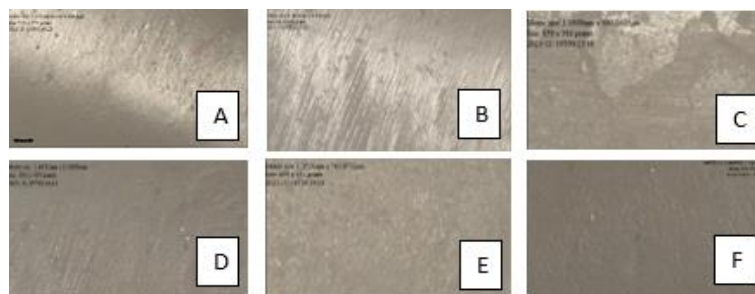

Fig 3. Surface Profilometric Images Of Group 2 – GC Gold Label Hybrid : A- After Initial Finishing And Polishing, B – After Thermocycling, C – After Manual Instrumentation, D – After Ultrasonic Instrumentation, E – Post Prophylactic Polishing(Manual Instrumentation Group) And F - Post Prophylactic Polishing(Ultrasonic Instrumentation Group)

Fig 4. Surface Profilometric Images Of Group 3 –Beautifil : A- After Initial Finishing And Polishing, B – After Thermocycling, C – After Manual Instrumentation, D – After Ultrasonic Instrumentation, E – Post Prophylactic Polishing(Manual Instrumentation Group) And F - Post Prophylactic Polishing(Ultrasonic Instrumentation Group)

IV. Discussion

Restorations on the gingival third of the facial and lingual surface of all teeth (except pit and fissure lesions) are termed as Class V[5]. With the advent of materials such as glass ionomer cements and its variants, which has the ability to adhere to tooth substance, the placement of Class V restorations has been considerably simplified[6]. Composites are one of the material of choice for restoring class V defects[7]. A new class of dental materials developed for the restoration of NCCLs are the fluoride-releasing resin materials composed of pre-reacted glass fillers called Giomers. It is a hybrid of glass-ionomer and resin-based composite with better color match, decreased microleakage, increased fluoride release, better surface finish and esthetic properties comparable to composites[8]. Extent to which the surface of various restorative materials undergoes degradation or sustained damage during prophylaxis depends on various factors including operator expertise, type of instrumentation technique, and instrument used. Since, the interproximal and cervical areas of the buccal and lingual aspects of anterior and posterior teeth are more vulnerable to the effect of prophylactic instrumentation, while choosing the material to be restored in these areas, it is important to consider their vulnerability to prophylactic instruments[4]. Surface roughness of the restorations can be measured up to nanoscale by various methods like scanning electron microscopy or quantitative methods, such as profilometry[9-13]. Profilometry analysis is the most common technique for surface roughness measurement[14]. Irrespective of the previous studies, this study uses 3D non-contact surface profilometer. After finishing and polishing of the restorations initial surface profilometric results showed that Group 1 (Omnichroma) had the highest surface roughness (Ra = 1.53) followed by Group 2 (GC Gold label hybrid) (Ra = 1.26) and the lowest surface roughness was for Group 3 (Beautifil) (Ra = 1.2). This mirrors the findings of El-Rashidy et al, who reported in 2022 that Omnichroma showed increased surface roughness after finishing and polishing when compared to Estelite Alpha composite[15]. Group 1(Omnichroma) showed a further increase in surface roughness after thermocycling. This was in accordance with Shalaby et al in 2022. This might be attributed to the uniform nano-spherical filler of silica and less heterogeneous composition of Omnichrom and also the absence of irregular edges in zirconia crystals likely resulted in uniform loss of surface texture[16]. Significantly, there was no change in surface roughness in Group 2 (GC Gold Label Hybrid) and Group3 (Beautifil). All the three class V restorative materials (Omnichroma, GC Gold label Hybrid and Beautifil) showed an increase in surface roughness after manual and ultrasonic prophylactic instrumentation, greatest for Group 1(Omnichroma) and lowest for Group 3(Beautifil). The roughness values were greater after manual prophylactic instrumentation than ultrasonic prophylactic instrumentation in all groups. Studies by Lai et al (2007), Mourouzis et al (2009), Eid HA et al (2013) and Erdilek, et al. (2015) has proven that sonic and USS increased the surface roughness of tooth-colored restorations[3,17-19]. Polishing of the scaled surfaces has been reported to help overcome the alterations in roughness thus preventing secondary caries, surface staining, plaque accumulation and subsequent periodontal inflammation[17]. Following post prophylactic polishing using prophylactic paste, all the groups showed an increased surface roughness,hence routine polishing of these materials should be avoided[10]. With respect to all the examined materials, Beautifil possesses the highest properties of fluoride release and recharge[20]. Naom and others in 2011 have proven that the mechanical properties of Beautifil do not diminish with ageing and fluoride release[21]. The wear resistance performance of Beautifil may be attributed to the enhanced filler distribution on the resin matrix or a difference in the filler size leading to homogeneity and maintenance of surface properties[22]. The results of current study shows that Beautifil is the best material for restoring class V lesions while considering the surface charecteristics of the materials. Although, GC Gold label hybrid is a proven material for as a class V restorations, its surface properties were shown to be inferior to Beautifil. Its's surface properties may be attributed to GC - Glass hybrid technology and fluoride releasing property[23,24]. Eventhough Omnichroma is the material with excellent colour matching ability as a class V restoration, its surface roughness stands out to be inferior compared to other materials used in the study. This is an in vitro study that is presented with some limitations. Even as every attempt was made to mimic clinical

situations and conditions within the framework of an in-vitro study, the results cannot be directly extrapolated to the chair side. Also the accuracy of the surface roughness detection in relation to the particle size is questionable. It was reported that surface roughness changes may be not be clearly if fillers size are much smaller than 1 μm[25]. Further studies should be performed to evaluate these materials in terms of other parameters for its effective clinical application.

V.   Conclusion

The clinical success of any restoration is influenced by a number of factors related to the oral environment of the host. Choice of a material for a particular restorative need would depend on more site-specific criteria. In Class V lesions, prophylactic instrumentation and post-polishing are two such factors, influencing the clinical performance of the restorative material. Within the limitations of the study, it may be concluded the Giomer Beautifil performs better than the Glass ionomer cement GC Gold Label Hybrid and the composite resin Omnichroma as evaluated by the values of surface roughness following exposure to a simulated oral environment.

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