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Keywords
Compomer; Composite; Glass ionomer; Surface roughness.

Abstract
Aim The aim of this study was to investigate the effect of two antierosive pastes, Pronamel and Tooth Mousse Plus, on surface roughness of two composite (Filtek Supreme Ultra Universal Restorative and TPH Spectrum Restorative), one compomer (Dyract Extra), and two conventional glass ionomer restorative materials (Ionofil U and SDI) Materials and methods Study design 14 discs (10 mm diameter x 2 mm thickness) were prepared for each material (n =14 x 5). The discs were randomly divided into two groups to receive either GC Tooth Mousse Plus application or Sensodyne Pronamel application with toothbrush. The surface roughness of the brushed samples were recorded by laser profilometer. Statistics Wilcoxon, Kruskal Wallis test and multiple comparison tests were used to analyse the data. Results It was revealed that the surface roughness of the Filtek Supreme, TPH, Dyract and Riva Selfcure materials were not affected from application of either pastes (p>0.005). However, surface roughness of manually mixed glass ionomer (Ionofil U) was significantly increased when brushed with both Tooth Mousse and Pronamel paste (p<0.001). Conclusion Neither Pronamel, nor Tooth Mousse caused a significant change on the surface roughness of tested restorative materials except Ionofil U. It was significantly increased following brushing with either paste.

Conclusion
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composite resins, one polyacid-modified composite resin and one conventional glass ionomer cement. Two null hypothesis were formulated: the surface roughness of all tested materials would be effected following application of either of the pastes; toothpaste and material type would affect the results.

Materials and methods

Two microhybrid resin composites (Filtek Supreme Ultra Universal Restorative, 3M ESPE, St. Paul, Minnesota, and TPH Spectrum Restorative, Dentsply, Germany), one componer (Dyract Extra, Dentsply, Germany), and two conventional glass ionomer cements (Ionofil U, VOCO, Cuxhaven, Germany) (Riva Self Cure, SDI Limited, Australia) were tested in this study. Fourteen discs (10 mm diameter x 2 mm thickness) were prepared for each material (n= 14 x 5) by the help of a prefabricated plexiglass mold. Ionofil U was prepared by mixing the powder and liquid for 30 s at room temperature (23 °C, 50% relative humidity) in accordance with the manufacturer’s directions. The other glass ionomer cement, Riva Self Cure (SDI Limited, Australia) was mixed with an amalgamator (Ultramat S, SDI Limited, Australia) for 10 s as in the manufacturer’s instructions. Both glass ionomers have a setting time of approximately 6 minutes (4.30 minutes for Riva and 5 minutes for Ionofil U respectively). Thus, following initial setting, all materials were placed in the discs. Mylar strips were placed over the top and bottom surfaces of the uncured resin composites and compomer and photopolymerisation was performed with a Quartz-Tungsten Halogen Dental Curing Light (Hilux OptiMax, Benloglu, Istanbul, Turkey) for 40 s on each side. The light output of the curing light unit (500 mW/cm²) was monitored with a hand-held dental radiometer (Model 100 Curing Radiometer, Demetron Research Corp., Danbury, CT, USA). Following setting and photopolymerisation, all specimens were taken out from the mold, immersed in tap water and stored in 37 °C, 50% relative humidity for 24 h. Then, both the top and bottom sides of all discs were polished by the same operator with 400, 600 and 1000 grid abrasive discs respectively. After each polishing step, specimens were ultrasonically cleaned and immersed in deionized water in order to remove the residues. For each type of material, the discs were randomly divided into two groups and received either GC Tooth Mousse Plus (Recaldent, Victoria, Australia) application or Sensodyne Pronamel (GlaxoSmithKline, Australia) application with tooth brush. To simulate home application procedures, 2 ml of paste was applied followed by 2 min. During the min, 120 brush strokes/min were applied manually by the same operator (ZY). The pastes were immersed in a plastic container and labelled as paste A and Paste B, the discs were numbered per group by a laboratory technician prior to brushing procedure. Following application of the paste, the specimen was rinsed under tap water and placed in distilled water until the next application. The application and washing procedures were repeated 2 times a day for one week.

The surface roughness of the samples was recorded by a laser profilometer (MicroXAM Interferometric Surface Profiler, Dublin, Ireland). The average surface roughness (Ra, µm) was measured using MapVue AE software, Version 1.2.0, from 3 tracings at 3 different locations on each specimen at baseline and following brushing procedure. For qualitative examination under scanning electron microscopy (SEM) (JEOL JSM 5200, Tokyo, Japan), 4 additional samples were prepared for each material, 2 for baseline evaluation and 2 for evaluation of the brushed surfaces. Specimens were sputter coated with gold and evaluated with accelerated voltage (20 kV) under SEM.

Statistical analysis

Statistical analysis was performed with the Statistical Package for Social Sciences (SPSS) 11.5 software (SPSS Inc., Chicago, IL, United States). Shapiro Wilk test was used to verify normal distribution of data. Homogeneity of variances was evaluated by the Levene test. Data were expressed as median (IQR). Wilcoxon test with Bonferroni correction was used to determine the possible difference among groups before and after brushing with tooth pastes and p<0.005 was set as significance. Mann Whitney U test was used to analyse the effect of tooth pastes on the baseline and final surface roughness of the restorative materials. According to Bonferroni correction, p<0.001 was set as significant (Table 1). Within tooth paste groups, the difference between baseline and final surface roughness of different

<table>
<thead>
<tr>
<th>GROUP</th>
<th>BASELINE</th>
<th>AFTER BRUSHING</th>
<th>P-VALUE</th>
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<tbody>
<tr>
<td>Ionofil U</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>1.77 (0.71)</td>
<td>2.15 (0.61)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Tm</td>
<td>2.35 (0.41)</td>
<td>2.91 (0.96)</td>
<td>&lt;0.001</td>
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<tr>
<td>TPH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>0.50 (0.13)</td>
<td>0.47 (0.61)</td>
<td>0.277</td>
</tr>
<tr>
<td>Tm</td>
<td>0.43 (0.13)</td>
<td>0.41 (0.08)</td>
<td>0.538</td>
</tr>
<tr>
<td>Dyract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>0.23 (0.08)</td>
<td>0.21 (0.06)</td>
<td>0.252</td>
</tr>
<tr>
<td>Tm</td>
<td>0.23 (0.08)</td>
<td>0.25 (0.06)</td>
<td>0.202</td>
</tr>
<tr>
<td>Filtek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>0.27 (0.10)</td>
<td>0.28 (0.10)</td>
<td>0.939</td>
</tr>
<tr>
<td>Tm</td>
<td>0.29 (0.07)</td>
<td>0.30 (0.08)</td>
<td>0.402</td>
</tr>
<tr>
<td>Riva Sefcure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>0.62 (0.43)</td>
<td>0.68 (0.31)</td>
<td>0.083</td>
</tr>
<tr>
<td>Tm</td>
<td>0.75 (0.39)</td>
<td>0.85 (0.26)</td>
<td>0.369</td>
</tr>
</tbody>
</table>

*p = Wilcoxon test with Bonferroni correction. Results are significant at p<0.005
restorative materials was evaluated with Kruskal Wallis test at p<0.025 confidence.

**Results**

When the intact (control) surfaces of tested materials were compared, the highest Ra values were observed in Ionofil group followed by Riva Selfcure, TPH, Filtek and Dyract respectively.

After brushing with Pronamel (PN) there was no significant difference between Ra values of baseline and brushed surfaces for Filtek, TPH, Dyract Extra and Riva Selfcure (p=0.939; p=0.277; p=0.252 and p=0.083 respectively). Similarly, brushing with Tooth Mousse (TM) yielded no significant difference between Ra values of the baseline and brushed surfaces for Filtek, TPH, Dyract Extra and Riva Selfcure (p=0.402; p=0.538; p=0.202 and p=0.369, respectively). Only Ionofil U displayed significantly rougher surface when brushed with either TM or PN (p<0.001). Briefly, application of either PN or TM did not have any significant effect on the surface roughness of the tested restorative materials except for Ionofil U (p>0.005 and p<0.001, respectively) (Table 1). Thus the first hypothesis was partially rejected, and the second null hypothesis was completely rejected.

**Scanning electron microscopy**

Qualitative evaluation of each material is given in Figures 1, 2, 3, 4, 5. In general, Tooth Mousse left clusters on the majority of the restorative materials. It...
Another problem in dental literature is that, the number of toothbrushing cycles needed to simulate 1 year’s toothbrushing remains unclear [Goldstein and Turner, 1991]. Ranges from 4,320 to 16,000 have been suggested [Kanter et al., 1982, Aker, 1982]. In the present study, we did not use a toothbrushing machine, but we used a standard number of strokes for each specimen and we intended to mimic a one-week oral hygiene procedure of an individual. While people might brush their teeth for 2 min, twice per day, it is likely that each tooth surface is only experiencing the brushing for a fraction of this time. Videotaped recordings of 31 patients and their toothbrushing habits revealed a mean stroke length of 1 cm/stroke and a brushing rate of 15 cm/s for circular toothbrushing [Volpenhein et al., 1994]. The patients spent 32 s on toothbrushing posterior segments on average, which would correspond to about 8 s for each posterior segment [Volpenhein et al., 1994]. As an outside estimate, each tooth may be brushed for 8 s per day, considering the individual brushes each tooth for 4 s twice a day. Based on an estimated brushing stroke in the oral cavity of 2 strokes per second, 1 min of brushing would produce 120 strokes. Therefore, in order to mimic the home procedure, we used 120 strokes/min. In dental literature, previously reported number of strokes per minute were 60, 90, 120 [Schätzk et al., 2009; Fujii et al., 2003; Da Costa et al., 2010]. The toothbrush selected for this study was a medium bristle toothbrush because it is the most recommended toothbrush by dentists [Da Costa et al., 2010].

Carvalho et al. [2008] evaluated the effect of different child tooth brushes on the surface roughness of conventional and resin-modified glass ionomer cements (RMGIC) in vitro. According to the results, manually mixed RMGIC showed the highest roughness values regardless of the type of tooth paste. This may be attributed to void formation when mixed manually. Thus, the type the restorative material per se is a determining factor on surface roughness values since the characteristics of fillers particle, such as size, composition, shape and size, as well as the entanglement of the resin and inorganic matrices, play an important role in the behaviour of restorative material. Sustaining research demonstrated that toothbrush abrasion of composite materials varied in accordance with the type of composite used [Kanter et al., 1982]. In the present study, only two composite materials (two microhybrid composites) were tested. Thus, further research is indicated to evaluate the effect of Tooth Mousse and Pronamel on different composite materials with various composition and particle sizes.

The type of dentifrice has also been reported as a factor related to composite wear [Goldstein and Turner, 1991; Wictorin, 1972]. The relative dentin abrasivity (RDA) of the toothpaste is a variable that influences the surface roughness of the restorative materials. An in

![FIG. 5 SEM picture of TPH composite material under 200x magnification. TM: Tooth Mousse specimen, P: Pronamel specimen, C: Control.](image-url)
vitro in corsivo study showed that the higher the RDA of the toothpaste is, the higher are both the surface roughness and wear of dental materials [McCabe et al., 2002]. Tooth mousse is a water-based, sugar free “topical cream” containing casein phosphopeptide and amorphous calcium phosphate. Since it is not a “toothpaste” there is no data regarding its RDA. It contains 55% water, 20% glycerol and 2% colloidal silica [GC Tooth Mousse Material Safety Data]. On the other hand, Pronamel is a derivative of Sensodyne toothpaste with high levels of bioavailable fluoride and has low RDA which is below 50% [Pronamel product information].

A recent review by Field et al. [2010] discussed about various surface quantifying and qualifying techniques and concluded that despite a variety of available in vitro tests for measuring surface changes, the roughness average (Ra) is still the main reported measurement within dental studies. However, the authors also proposed combination of the techniques. Thus, further research is indicated to assess the qualitative and quantitative changes on the restorative materials caused by Tooth Mousse and Pronenamel with different methods including qualitative evaluation.

During toothbrushing, the toothpaste is quickly diluted by saliva. In the present study, the pastes were not diluted prior to application according to the manufacturers’ directions. It could be argued that if a patient was brushing with these products, then this contact time with the restorative material would be reduced due to dilution of the pastes in oral cavity by saliva. Although this effect is simulated by diluting the toothpaste with water in in vitro studies; further special properties of saliva other than dilution, such as specific proteins and ions that may diminish the roughening effect, cannot be simulated [Heintze et al., 2010].

Since there is no previous data regarding the effects of these two pastes on the surfaces of restorative materials, no comparison could be made. Within the limitations of this in vitro preliminary study, the following conclusions were drawn:

- When the initial and final surface roughness of the tested materials are compared, neither Pronamel nor Tooth Mousse caused a significant change on the surface roughness of tested composites, compomer and Riva Self Cure. However, surface roughness of Ionofil U was significantly increased following brushing with either paste.
- Further laboratory research and in vivo studies are needed to understand the effects of Pronamel and Tooth Mousse on various tooth-colored restorations.

References

- Pronamel product information, www.dental-professional.com