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Surface Roughness Changes of Different Restoration Materials after Tooth Brushing Simulation Using Different Toothpastes

Csaba Dudás[1], Zoltán Forgó[2], Bernadette Kerekes-Máthé[3]

[1] Faculty of Dentistry, University of Medicine and Pharmacy, Tîrgu Mureș, Romania

[2] Department of Mechanical Engineering, Sapientia University, Tîrgu Mureș, Romania

[3] Department of Morphology of Teeth and Dental Materials, Faculty of Dentistry, University of Medicine and Pharmacy, Tîrgu Mureș, Romania

CORRESPONDENCE

Bernadette Kerekes-Máthé
Str. Revoluției nr. 27
540042 Tîrgu Mureş, Romania
Tel: +40 746 239 180
E-mail: bernadette.kerekes@umftgm.ro

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Csaba Dudás • Str. Gheorghe Marinescu nr. 38, 540139 Tîrgu Mureș, Romania, Tel: +40 265 215 551

Zoltán Forgó • Șos. Sighișoarei nr. 1C, 540485 Corunca, Romania, Tel: +40 265 206 210

ABSTRACT

Background: The need for the whitening effects of toothpastes became primary for most users. Changes in the surface roughness of restoration materials after tooth brushing are inevitable, and the abrasion is known to increase the possibility of dental plaque accumulation. Aim of the study: To evaluate in vitro surface roughness changes of different dental restorative materials after tooth brushing simulation. **Material and methods:** Fifty specimens of two composite materials (Evicrol, Super-Cor), two glass ionomer materials (Glassfill, Kavitan Cem) and a silicate cement (Fritex) were prepared according to the manufacturer's instructions. Each group of specimens was divided in three subgroups for tooth brushing simulation: using two different types of toothpaste and without toothpaste. Before and after 153 hours of tooth brushing simulation with a custom-made device, the surface roughness was measured with a surface roughness tester. Statistical analysis was performed after collecting the data. **Results:** All materials exhibited changes in surface roughness after the use of both toothpastes. The self-curing composite showed the less change and glass ionomer materials showed the greatest changes in surface roughness. **Conclusions:** The surface changes of dental materials depended on their composition and the cleaning procedure. Although self-curing composite was the most resistant to surface changes, its surface roughness values were high. Light-curing composite presented the lowest surface roughness values, even after brushing with toothpastes. The "medium" labeled toothbrush caused significant changes without toothpaste on the surface of light-curing composite, glass ionomer and silicate cement materials.

Keywords: dental material, surface analysis, tooth brushing simulation

INTRODUCTION

The oldest method of tooth care is the use of plants, root and flower extracts. In prehistoric times, people knew about the abrasive effect of powders, which resulted in a cleaning effect.[1] In recent years, the need for the whitening effects of toothpastes and polishing materials became primary for users.[2]

The first generation of esthetic restorative materials was the silicate cement. The drawbacks of this material (solubility, shrinkage, discoloration, acidity) affect its durability, thus the development of new materials became inevitable. The launch of the first composites solved the problem of acidity and shrinkage, but the clinical experiences were less favorable as expected.[3] Conventional glass ionomer cements resulted from the hybridization of silicate cements and zinc polycarboxylates.[4] Their advantage lies in their fluoride release capacity.

Changes in the surface roughness of restoration materials after tooth brushing are inevitable, and the abrasion is known to increase the possibility of dental plaque accumulation.[5] Another effect of tooth brushing is the decrease in gloss shown by several studies that examined the resin composites.[6–8] Clinically, decrease in gloss due to mechanical and chemical interaction can cause esthetic problems especially in patients who present a high lip line.[9]

Today, when caries is one of the most important civilization diseases and esthetic restorations are developing continuously, patients and clinicians are interested in evidence-based facts. The aim of this study was to evaluate in vitro surface roughness changes of different dental restorative materials after tooth brushing simulation.

MATERIAL AND METHODS

A total number of fifty specimens of different types of restorative materials were prepared according to the manufacturer's instructions: self-curing composite (Evicrol, SpofaDental, Czech Republic), light-curing composite (Super-Cor, SpofaDental, Czech Republic), two glass ionomer materials (Glassfill, Pulpdent, Watertown, USA and Kavitan Cem, SpofaDental, Czech Republic), and a silicate cement (Fritex, SpofaDental, Czech Republic). A custom-made silicone mold was used to obtain the specimens. The mold was placed on a smooth glass surface in order to obtain plain specimen surfaces.

Each group of specimens was divided in three subgroups for tooth brushing simulation. Two types of toothpastes were used for the simulation: Blend-a-Med Pro Expert All in One Fresh Mint (Procter & Gamble, Cincinnati, OH, USA) and NeoBio Fluoridfrei Zahncreme (Neobio, Hannover, Germany). Toothpaste slurry was obtained after mixing a pea-sized amount of toothpaste with a drop of tap water. Every third subgroup from each material group underwent a tooth brushing simulation with only tap water.

A tooth brushing simulation device (Figure 1) was constructed as a result of an interdisciplinary teamwork. The device has the following specifications:

- medium-labeled electronic tooth brush (DontoDent Akku-Zahnbürste Active Professional, dm-drogerie markt GmbH, Karlsruhe, Germany);
- constant force of 2N;
- re-enforced structure enabling the elimination of vibrations;
- variable power supply;
- compliance with ergonomic standards.

Each specimen was subjected to 183.6 minutes (3.06 hours) of brush simulation with 8,800 oscillating movements per minute. Multiple surface roughness measurements were made in order to provide the most accurate information. Each measurement was performed twice diagonally, resulting in a total number of four measurements per specimen. This procedure was applied before and after the simulated tooth brushing, resulting in a total of 400 diagonal measurements. A surface roughness tester (Surtronic 25, Taylor Hobson, Leicester, UK) was used, and the results were processed in the Talyprofile software (Taylor Hobson, Leicester, UK). The unit was able to measure amplitude parameters, the vertical characteristics of the surface deviations. From these parameters Ra (arithmetic mean deviation) and Rz (average peak-to-valley height) were used for this study.

Data were collected and statistical tests were performed using the GraphPad InStat software (GraphPad, San Diego, CA, USA). After verifying the outliers, the normal distribution of data was checked. Student's t-test was performed in order to assess the differences between the groups.

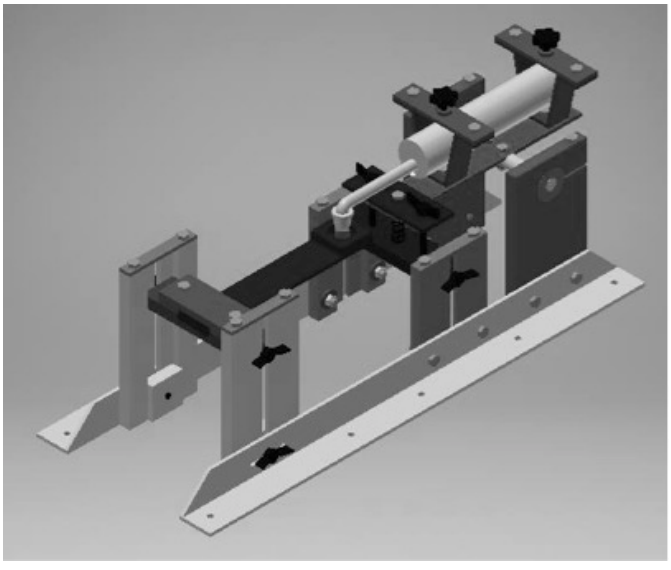

FIGURE 1. Computer-aided design of the tooth brushing simulation device

TABLE 1. Average values of measurements before and after simulation (μm)

	Blend-a-Med			NeoBio			Without dentifrice		
	before	after	p value	before	after	p value	before	after	p value
Evicrol	1.59	1.68	0.12	1.73	2.09	0.56	1.27	1.76	0.14
Super-Cor	0.24	0.34	0.31	0.12	0.47	0.03	0.32	0.87	0.03
Kavitan Cem	1.04	1.38	0.15	1.29	1.69	0.007	1.17	1.69	0.62
Glassfill	0.57	0.81	<0.00001	0.58	0.83	0.01	0.71	0.44	0.03
Fritex	1.28	1.69	0.03	1.67	2.42	0.15	1.44	1.80	0.03

RESULTS

Tooth brushing simulation performed with two different toothpastes resulted in an increased value of surface roughness on almost all specimens. Significant changes were found in case of the Glassfill glass ionomer and Fritex silicate cement samples after simulation with whitening toothpaste. The use of bio-toothpaste also resulted in an increase, but in this case significant changes occurred in connection with the SuperCor composite and the Kavitan Cem and Glassfill glass ionomer samples. Experiments without toothpaste provided significant changes in the following materials: SuperCor, Glassfill, Fritex. Surface roughness values were significantly decreased only in the Glassfill samples after simulation without toothpaste (Table 1).

DISCUSSIONS

The surface roughness of different types of restorative materials after tooth restoration is determined not only by their chemical properties, but also by the regular use of different toothpastes. Differences were observed in case of the same type of materials produced by different companies.

The toothpastes used in the present study for tooth brushing simulation have different abrasive particle content. NeoBio has in its composition calcium carbonate, silica, sea salt, while Blend-a-med Pro Expert contains hydrated silica and silica.

Data from published scientific studies showed that sodium bicarbonate has stronger abrasive characteristics compared to salt.[10] The results of our study partially confirmed that the hydrated silica-containing toothpaste (Blend-a-Med Pro Expert All in One Fresh Mint) has abrasive characteristics, causing significant changes on Glassfill and Fritex specimens. On the other hand, the sea salt-containing material without hydrated silica (NeoBio) produced significant surface roughness changes on Super-Cor, Kavitan Cem and Glassfill specimens.

Some studies showed that the daily use of specified dentifrice products results in smoother surfaces after tooth brushing.[11] In the present study, only a few specimens did not show abrasion, while significant improvement of surface roughness values were present only in Glassfill specimens after tooth brushing simulation without using any dentifrice. According to the scientific literature, toothbrush abrasion is determined by the type of material and the abrasive particle content of the toothpaste.[9,12]

In the case of intraoral hard surfaces, a threshold roughness of 0.2 μm is present according to in vivo studies. Above this value the increase of plaque accumulation, risk of caries and periodontal inflammation is more prominent.[13] Although during specimen preparation the mold was placed on a smooth glass surface, the measurements showed that only the light-curing composite specimens had values near the threshold roughness initially. After tooth brushing simulation these values exceeded the threshold, too. Choosing a restorative material with a low surface roughness value and resistance to abrasion is most important at the cervical margins of the teeth, where plaque accumulation affects gingival health.

Further studies are planned to evaluate different types of light-curing composite materials using different types of toothpastes and soft labeled toothbrushes.

CONCLUSIONS

Not all mechanical cleaning techniques that involve the use of a toothbrush with different toothpastes have a significant negative effect on surface roughness changes of different restoration materials. Although self-curing composite was the most resistant to surface changes, its surface roughness values were high. Light-curing composite presented the lowest surface roughness values, even after brushing with toothpastes. The toothpaste with a whitening effect resulted in less abrasion on the samples' surface than the bio-toothpaste. The medium toothbrush itself

caused abrasion to the restorative materials used in this study, which strengthens the indication to use soft toothbrushes.

CONFLICT OF INTEREST

The authors have no financially conflicting relationships with the companies whose materials were included in this article.

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