Toothbrushing and Dentifrices on Roughness of Pediatric Zirconia Crowns

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Introduction

- Dental caries, despite its preventable aspect, is the most common chronic disease in children. There are several risk factors in dental caries. One of the factors for dental caries is the bacteria in plaque accumulation.
- Since 2010, zirconia crowns (ZRCs) have been one of the common restorative choices in pediatric dentistry. ZRCs are biocompatible, durable, and less plaque-retentive. Due to the strength of the material and the esthetics of the restoration, ZRCs are often more preferred by the parents and the patients. Studies have examined the initial mechanical properties of ZRCs, but no study has specifically analyzed the changes in the surface roughness in prefabricated pediatric ZRCs following ample strokes of toothbrushing.
- The effect of toothbrushing on the surface roughness of ZRCs may be a significant factor in determining the performance of the restoration. The mechanical force from daily toothbrushing and the abrasiveness of dentifrices are major contributing factors causing superficial abrasion and changes in the surface roughness by physically affecting the restorations. Several studies have shown different mechanical and chemical forces affecting the surface roughness of various materials, such as resin composites and CAD-CAM ceramic; however, limited studies have investigated the impact of toothbrushing and dentifrices on the surface roughness of prefabricated ZRCs.
- This study evaluated the effect of toothbrushing and dentifrices on the surface roughness of three different brands of prefabricated pediatric ZRCs. The abrasivities of the toothbrushing were represented by different dentifrices with a range of abrasivities. These were selected based on the relative dentin abrasivity (RDA).

Purpose

The purpose of this study was to evaluate any significant changes in the surface roughness of prefabricated ZRCs from the abrasivity of toothbrushing and dentifrices.

Materials and Methods

Sample Selection: 32 pediatric maxillary right central incisor ZRCs in the largest available size from 1) Kinder Krowns, 2) Nusmile, 3) Sprig.
Group assignment: Eight ZRCs from each manufacturer were divided into four groups of dentifrices with different abrasivities: Tom's of Maine Children's (low RDA), Crest Kid's (medium RDA), Prevident 5000 Original (high RDA), and Crest Pro Health Whitening (harmful RDA).
Testing variables: 1) Average roughness (R_a) and 2) Mean roughness depth (R_z).
Intervention: All ZRCs were brushed according to their assigned groups, using a standard V8 cross-brushing machine with selected dentifrices at 150 strokes/minute. A total of 10,000 strokes were performed to simulate 12 months of brushing.
Measurements: Both baseline and experimental values of R_a and R_z were measured with a Bruker DektakXT Stylus Profilometer.
Statistical Analysis: Data were analyzed for the surface roughness independently using two-way ANOVA with the Holm-Sidak method (α=0.05).

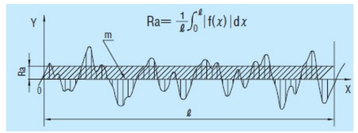


Figure 1. Definition of average roughness

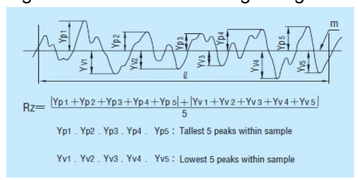
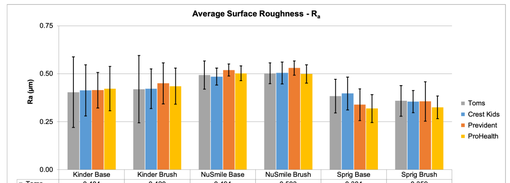


Figure 2. Definition of mean roughness depth

The crowns were brushed according to their groups. 38g of dentifrices were mixed with 60g of water to create a liquid solution for the crowns to be submerged while brushing. One cycle of brushing consisted of 2,500 strokes, and a total of four cycles were completed for each experimental group. After each cycle, all samples were rotated 180° and moved to a different slot through eight brushing stations to minimize possible brushing errors from a specific toothbrush.

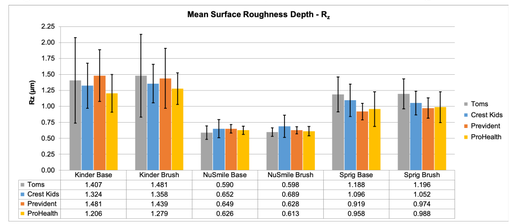
Results

Average baseline R_a and R_z for each brand of ZRCs with assigned dentifrices are shown in Figure 3 and Figure 4. Variabilities of the baseline values within the same brand were indicated, yet no statistical significance was shown. NuSmile crowns had the largest baseline R_a; whereas Sprig had the smallest baseline R_a.



	Kinder Base	Kinder Brush	NuSmile Base	NuSmile Brush	Sprig Base	Sprig Brush
Toms	0.404	0.420	0.494	0.503	0.384	0.359
Crest Kids	0.414	0.422	0.485	0.504	0.397	0.355
Prevident	0.414	0.450	0.520	0.530	0.339	0.356
ProHealth	0.423	0.435	0.503	0.499	0.319	0.325

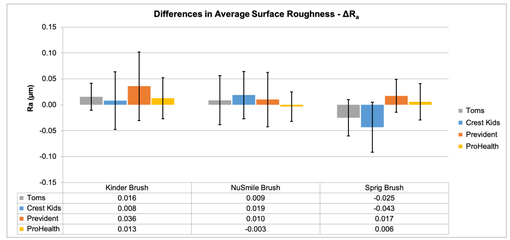
Figure 3. Pre-intervention and post-intervention R_a



	Kinder Base	Kinder Brush	NuSmile Base	NuSmile Brush	Sprig Base	Sprig Brush
Toms	1.407	1.481	0.590	0.598	1.188	1.196
Crest Kids	1.324	1.358	0.652	0.689	1.096	1.052
Prevident	1.481	1.439	0.649	0.628	0.919	0.974
ProHealth	1.206	1.279	0.626	0.613	0.958	0.988

Figure 4. Pre-intervention and post-intervention R_z

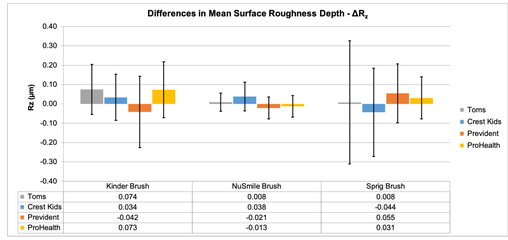
Based on the tables below the figures, the changes in the surface roughness of all ZRCs after the intervention were below 0.1 μm.



	Kinder Brush	NuSmile Brush	Sprig Brush
Toms	0.016	0.009	-0.025
Crest Kids	0.008	0.019	-0.043
Prevident	0.036	0.010	0.017
ProHealth	0.013	-0.003	0.006

Figure 5. ΔR_a of ZRCs post-intervention

Results



	Kinder Brush	NuSmile Brush	Sprig Brush
Toms	0.074	0.008	0.008
Crest Kids	0.034	0.038	-0.044
Prevident	-0.042	-0.021	0.055
ProHealth	0.073	-0.013	0.031

Figure 6. ΔR_z of ZRCs post-intervention

Without any specific direction of the data, no correlation was found between the surface roughness and brushing with different abrasivities. The 2-way ANOVA indicated statistically significant differences in ΔR_a of Sprig and NuSmile using Crest Kid's (P<.05). No significantly different ΔR_z was found among all ZRCs.

Conclusions

Despite its statistical significance, with changes in the surface roughness (ΔR_a and ΔR_z) at a μm scale, it was difficult to indicate any signs of clinically significant differences. Although this study did not address how toothbrushing and different dentifrices may affect the mechanical properties, durability, and/or retention properties of ZRCs, the study's results provide confidence to clinicians when using prefabricated pediatric ZRCs as a sustainable treatment option.

Acknowledgments

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