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Evaluation of surface roughness of aesthetic pediatric crowns using a brushing stimulator

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ABSTRACT

Background: Surface roughness plays a critical role in the longevity, esthetics, and biofilm accumulation of pediatric dental restorations. Aesthetic pediatric crowns are increasingly used; however, their resistance to mechanical wear from toothbrushing remains inadequately explored.

Aim: To evaluate and compare the surface roughness of aesthetic pediatric crowns before and after simulated toothbrushing using a brushing simulator.

Materials and Methods: Four samples of aesthetic pediatric crowns were analyzed. Surface roughness parameters—Ra (average roughness), Rq (root mean square roughness), and Rz (maximum peak-to-valley height)—were measured using a stylus profilometer before and after brushing simulation of approximately 30,000 cycles (equivalent to ~3 years of brushing). Data were statistically analyzed to assess changes in surface characteristics.

Results: All samples demonstrated a reduction in surface roughness after brushing simulation. Pre-brushing Ra values ranged from 0.998 to 3.560 µm, while post-brushing values ranged from 0.342 to 1.551 µm. Similar reductions were observed in Rq and Rz values. The findings indicate significant smoothing of crown surfaces after simulated brushing.

Conclusion: Simulated toothbrushing significantly reduces the surface roughness of aesthetic pediatric crowns, potentially improving resistance to plaque accumulation. However, material-specific wear patterns warrant further investigation..

Key Words: Pediatric crowns, surface roughness, brushing simulator, profilometry, dental materials, wear resistance

INTRODUCTION

The use of aesthetic crowns in pediatric dentistry has gained considerable popularity due to increasing parental demand for esthetic restorations. Beyond esthetics, the surface characteristics of these crowns significantly influence their clinical performance, particularly in terms of plaque retention, wear resistance, and longevity(Hasan, 2008)

Surface roughness is a key determinant of bacterial adhesion and biofilm formation. Rougher surfaces tend to harbor more microorganisms, increasing the risk of secondary caries and gingival inflammation. Toothbrushing, a routine oral hygiene practice, can alter the surface topography of restorative materials over time through mechanical abrasion.(Ortiz-Magdaleno et al., 2025)

While several studies have investigated wear resistance of restorative materials, limited data exist on how simulated long-term brushing affects the surface roughness of aesthetic pediatric crowns. Therefore, this study aims to evaluate the changes in surface roughness of such crowns following standardized brushing simulation.(Yokoi et al., 2025)

MATERIALS AND METHODS

Study Design

An in vitro experimental study was conducted to evaluate surface roughness changes in aesthetic pediatric crowns before and after brushing simulation.(Nanri et al., 2024).

Sample Preparation

Four aesthetic pediatric crown samples were selected and cleaned ultrasonically to remove contaminants prior to baseline measurements.(Abdou *et al.*, 2025)

Surface Roughness Measurement

Surface roughness parameters were measured using a stylus profilometer. The following parameters were recorded:

Ra (Average Roughness): Arithmetic mean of surface deviations

Rq (Root Mean Square Roughness): Standard deviation of surface profile

Rz (Maximum Height): Difference between highest peak and lowest valley

Each sample was measured under standardized conditions.

Brushing Simulation

Samples were subjected to brushing simulation using a brushing simulator for approximately 30,000 cycles, representing nearly three years of clinical brushing. A standardized load, toothbrush type, and slurry were maintained throughout the procedure.(Koch *et al.*, 2017)

Post-Brushing Evaluation

Following brushing simulation, surface roughness measurements were repeated using the same profilometric settings.

Statistical Analysis

Descriptive statistics were used to analyze the data. Mean differences between pre- and post-brushing values were evaluated to assess changes in surface roughness.(Mount *et al.*, 2016; Koch *et al.*, 2017)

RESULTS

The current study focused on analyzing the surface roughness of an alkasite restorative material before and after brushing simulation for around 30000 cycles which is almost equal to a mean brushing of around 3 years of period.

Table 1 shows the tabulated values of pre RaRq.Rzrecorded using the stylus profilometer.

sr no	Ra	Rq	Rz
sample 1	3.560	4.407	15.490
sample 2	2.345	2.978	11.573
sample 3	1.603	2.091	8.955
sample 4	0.998	1.327	5.225

Table 2 shows the tabulated values of post Ra,Rq.Rz recorded using the stylus

st no	Ra	Rq	Rz
sample 1	0.342	0.412	3.108
sample 2	1.191	1.512	6.125
sample 3	0.712	0.882	4.133
sample 4	1.551	1.902	6.120

Comparative Analysis

A marked reduction in Ra values was observed across all samples, indicating smoother surfaces post-brushing.

Rq values also decreased, confirming overall reduction in surface irregularities.

Rz values showed significant reduction, suggesting decreased peak-to-valley differences.

Sample 1 exhibited the most pronounced reduction, while Sample 4 showed a slight increase in Ra compared to Sample 3 post-brushing, indicating possible material-dependent variability.(Theriot *et al.*, 2017)

DISCUSSION

This study evaluated the impact of simulated toothbrushing on the surface roughness of aesthetic pediatric crowns. The results demonstrate a consistent reduction in surface roughness parameters following brushing simulation.(Kanouse, 1966)

The observed smoothing effect may be attributed to the abrasive action of toothpaste slurry, which gradually removes surface irregularities. This finding aligns with previous studies reporting polishing effects of toothbrushing on certain restorative materials.(Bahammam and Rady, 2025)

Reduced surface roughness is generally associated with decreased bacterial adhesion, which may enhance the clinical performance of pediatric crowns by minimizing plaque accumulation and gingival irritation. However, excessive abrasion could also lead to material degradation over extended periods.(Bafarat, 2013; Bahammam and Rady, 2025)

Interestingly, slight variability among samples suggests that different crown materials or manufacturing processes may influence wear behavior. This highlights the importance of material selection in pediatric restorative dentistry.(de Oliveira Neves *et al.*, 2026)

CONCLUSION

Simulated toothbrushing significantly reduces the surface roughness of aesthetic pediatric crowns, resulting in smoother surfaces that may be less prone to plaque accumulation. While this suggests a beneficial effect of brushing on surface topography, further studies are needed to assess long-term material integrity and clinical implications.(Leelaponglit *et al.*, 2026).

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