Comparative Evaluation of Surface Roughness Between Two Different Commercially Available Adult toothpastes Manufactured for Dentinal Sensitivity - an in Vitro Study

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**Abstract:** Introduction: Post-brushing roughness refers to the tactile perception of an increased rough or gritty sensation on the tooth surface after brushing. Through an In Vitro study measuring their impact on surface roughness, it adds to our knowledge of dental care, potentially leading to improved recommendations for individuals with sensitive teeth and promoting better oral healthTo evaluate and compare the Surface Roughness between Two Different Commercially Available Adult toothpastes manufactured for dentinal sensitivity8 Natural Tooth samples- 4 permanent,4 deciduous were collected and Surface Roughness value (Ra-average roughness of tooth surface) using stylus profilometer was calculated. The samples were mounted in the brushing simulator for 10000 cycles in Horizontal, Vertical and Circular motion. Brushing for the first 4 samples was done using Colgate Sensitive and for the remaining 4 samples using Sensodyne, using a common toothbrush specifically designed for dentinal sensitivity. Post brushing for 10,000 cycles, the Surface roughness (Ra-average roughness of tooth surface) value was again calculated. To evaluate the surface roughness of the teeth using two different commercially available toothpastes specifically designed for desensitization simulated by tooth brushing. Results were evaluated. The pre and post values signify that there was increase in the surface roughness of the natural teeth post one year of brushingFrom the above study, a significant correlation was observed between post brushing surface roughness and toothpastes for dentinal sensitivity

**Keywords:** Educating patients, Experimental Venue and Ethical Considerations, Sample Preparation and Decontamination

# Introduction

Post-brushing roughness refers to the tactile perception of an increased rough or gritty sensation on the tooth surface after brushing. This roughness can be subjective and may vary depending on various factors, including the toothbrush used, brushing technique, and individual differences in tooth sensitivity [(Ramsundar et al., 2023; Rieshy et al., 2023; Singh et al., 2023)](https://paperpile.com/c/W6DRcv/U0PlZ+lYCmf+BKj2H). The phenomenon can be particularly concerning as it may impact an individual's perception of oral hygiene and comfort, potentially influencing their brushing habits and overall oral care routine.[(AlAli et al., 2021)](https://paperpile.com/c/W6DRcv/YUu1)There are a few possible causes of post-brushing roughness. Over time, if you brush your teeth too aggressively or use a toothbrush with hard bristles, it can lead to enamel abrasion. This can create a rough surface texture on the teeth. In some cases, the rough sensation may be due to residual toothpaste or food particles that were not completely removed during brushing. If these substances are not rinsed away thoroughly, they can leave a gritty sensation [(Pavithra et al., 2023; Shenoy et al., 2023; Thomas & Jain, 2023)](https://paperpile.com/c/W6DRcv/EufYW+xVI8r+sfV4P). Teeth that are already sensitive due to factors like enamel erosion, exposed dentin, or gum recession may exhibit increased post-brushing roughness. Sensitivity can make the tooth surface feel rougher than usual (3). Tooth surface roughness can affect oral health in various ways, including inadequate plaque removal, plaque accumulation, stain retention, enamel erosion, and aesthetics. Toothpaste is an important component in the cause of abrasion. Most toothpastes have abrasives like calcium phosphate and calcium carbonate for removing stains and debris to improve teeth health [(Doshi et al., 2023; Lampl et al., 2023; Pandiyan et al., 2023)](https://paperpile.com/c/W6DRcv/VkDEP+iDxFW+alZeR).The abrasiveness of toothpaste is a double-edged sword; while abrasives like calcium phosphate and calcium carbonate are crucial for removing plaque and stains, they can also contribute to enamel wear if used excessively or improperly[(Janani et al., 2021; Kachhara et al., 2021; Subramanian et al., 2023)](https://paperpile.com/c/W6DRcv/Lj9y0+SEjzv+5ksob). This creates a challenge in formulating toothpaste that effectively cleans without damaging the enamel. Overly abrasive toothpaste can exacerbate post-brushing roughness, especially in individuals with already compromised enamel or dentin exposure. Consequently, dental professionals often recommend using toothpaste specifically designed to balance cleaning efficiency with minimal abrasivity to maintain the integrity of the tooth surface[(Enax et al., 2023)](https://paperpile.com/c/W6DRcv/4Xwf).In addition to toothpaste formulation, brushing technique plays a significant role in post-brushing roughness[(Gandhi et al., 2021; Katyal et al., 2023; Priyadharshini et al., 2023)](https://paperpile.com/c/W6DRcv/eTaLJ+Y9cTz+zZp1p). Proper brushing techniques, such as using gentle circular motions rather than aggressive back-and-forth scrubbing, can help minimize enamel abrasion and reduce the risk of creating a rough tooth surface. Using a toothbrush with soft bristles and brushing for the recommended two minutes twice a day can also help mitigate roughness. Educating patients on the correct brushing methods is crucial for preventing both enamel wear and the uncomfortable sensation of rough teeth after brushing[(Kumar et al., 2015)](https://paperpile.com/c/W6DRcv/VhdB).Dentinal sensitivity, also known as tooth sensitivity, is a condition characterized by a sharp, temporary pain or discomfort in the teeth when exposed to certain stimuli. The sensitivity occurs when the dentin, which is the layer of the tooth beneath the enamel and cementum, becomes exposed [(Chokkattu et al., 2023; Dharman et al., 2023; Govindaraj & Shanmugam, 2023)](https://paperpile.com/c/W6DRcv/gCMig+W1XjB+R4txs). Dentin contains tiny tubules that connect to the nerve endings of the tooth, allowing sensations to be transmitted to the nerves. When the dentin is exposed, stimuli such as hot or cold temperatures, sweet or acidic foods, or even air can cause the nerve endings to react, leading to sensitivity and discomfort. Various factors can contribute to dentinal sensitivity, including tooth enamel erosion, gum recession, tooth decay, teeth grinding, or dental procedures [(Rajeshkumar & Lakshmi, 2021; Sivakumar et al., 2021)](https://paperpile.com/c/W6DRcv/ntxpm+JGeVv). The relative dentin abrasiveness is the measurement of toothpaste abrasivity, and any toothpaste with a score below 100 is safe for preventing enamel abrasion. Hence, we have chosen Colgate Sensitive and Sensodyne. Here we have seen desensitizing toothpastes to treat sensitivity [(Chokkattu et al., 2023; Dharman et al., 2023; Govindaraj & Shanmugam, 2023)](https://paperpile.com/c/W6DRcv/gCMig+W1XjB+R4txs).By assessing the impact of desensitizing toothpastes on tooth surface roughness, researchers and dental professionals can make more informed recommendations about the appropriate use and long-term effects of these toothpastes.[(Kumar et al., 2015)](https://paperpile.com/c/W6DRcv/VhdB) This study aimed to evaluate and compare the surface roughness between two different commercially available adult toothpastes manufactured for dentinal sensitivity - an in vitro study. This knowledge can contribute to optimizing oral care strategies and ensuring that desensitizing toothpastes provide effective relief from tooth sensitivity without compromising other aspects of tooth health and integrity (10). The findings of this research could guide future innovations in toothpaste formulations, balancing the need for effective cleaning, enamel preservation, and sensitivity reduction. Furthermore, understanding the nuances of post-brushing roughness could lead to better patient education and improved oral hygiene practices tailored to individual needs.

# Materials and Methods

## Experimental Venue and Ethical Considerations

The current in vitro investigation was conducted at the White Laboratory, Extracted permanent incisor teeth were procured following a comprehensive ethical protocol. Informed written consent was meticulously obtained from all study participants, explicitly delineating the research utilization of extracted dental specimens.

## Sample Preparation and Decontamination

Dental specimens underwent rigorous preliminary processing to ensure experimental integrity. The coronal tooth segments were immersed in a 5.25% sodium hypochlorite solution, effectively eliminating residual hard and soft tissue contaminants. Prepared specimens were subsequently preserved in sterile saline solution until experimental procedures were initiated.

## Sample Selection Criteria

Prior to experimental analysis, a comprehensive visual and tactile examination was performed on each dental specimen. Teeth exhibiting visible pathological manifestations—including caries, structural fractures, or microfractures—were categorically excluded from the research cohort. Specimens with pre-existing restorations or identifiable structural anomalies were systematically eliminated to maintain experimental rigor and data reliability.

## Baseline Topographical Characterization

Initial surface morphological characteristics were quantitatively assessed utilizing a Mitutoyo SJ 310 stylus profilometer. This precision instrument provided comprehensive baseline measurements of surface roughness and topographical configuration. Dental specimens were subsequently mounted on die stone substrates to facilitate standardized experimental manipulation.

## Experimental Design

The dental specimens were systematically stratified into two discrete experimental groups, each comprising ten individual samples:

1. Group 1: Specimens subjected to mechanical abrasion using Colgate Sensitive toothpaste
2. Group 2: Specimens subjected to mechanical abrasion using Sensodyne toothpaste

## Brushing Simulation Protocol

Mounted samples were positioned within a specialized dental brushing simulator (ZM3.8 SD Mechatronik), designed to replicate standardized mechanical abrasion conditions. Each specimen underwent 30,000 brushing cycles, which empirically correlates with a three-year clinical tooth brushing trajectory. A standardized soft-bristled toothbrush was employed to ensure consistent experimental parameters.

## Post-Experimental Surface Analysis

Following the simulated brushing protocol, dental specimens underwent comprehensive re-evaluation of surface topographical characteristics. Surface roughness measurements were acquired utilizing the identical stylus profilometer, enabling precise quantification of morphological alterations induced by experimental conditions.

# Statistical Methodology

Collected experimental data underwent rigorous statistical analysis employing one-way analysis of variance (ANOVA). Statistical significance was predetermined at a probability threshold of p ≤ 0.05, ensuring robust interpretative validity of the experimental findings. Data processing and statistical computations were executed using SPSS statistical software.

# Results

Table 1: Pre and Post brushing surface roughness values in the groups of the present study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group** | **Pre-Brushing**  **(Mean ± SD)** | **Post-Brushing**  **(Mean ± SD)** | **Mean Difference**  **(Mean ± SD)** | **P-VALUE** |
| Sensodyne | 3.60075 ± 0.065 | 3.61124 ± 0.034 | -0.01049 ± 0.022 | 0.032 |
| Colgate Sensitive | 3.57725 ± 0.045 | 3.60825 ± 0.023 | -0.03100 ± 0.018 |  |

The comparative assessment of surface roughness modifications pre- and post-brushing within the experimental cohorts is delineated in Table 1. The Sensodyne group exhibited a baseline surface roughness value of 3.60075 ± 0.065, which marginally increased to 3.61124 ± 0.034 following the brushing regimen. The computed mean difference in roughness, quantified as -0.01049 ± 0.022, was statistically significant (p = 0.032), indicating a discernible, albeit minor, alteration in surface characteristics. Conversely, specimens subjected to Colgate Sensitive demonstrated an initial roughness measurement of 3.57725 ± 0.045, which increased to 3.60825 ± 0.023 after brushing. The corresponding mean difference, calculated at -0.03100 ± 0.018, suggested a more pronounced modification in surface topography compared to the Sensodyne cohort. However, the statistical significance of this change remains unspecified within the present dataset.These findings suggest that both desensitizing dentifrices exerted perceptible effects on surface roughness, with Colgate Sensitive exhibiting a greater magnitude of alteration. The clinical implications of these textural modifications warrant further scrutiny, particularly concerning their potential impact on enamel integrity and long-term dentin hypersensitivity management.

# Discussion

Tooth sensitivity is a widespread dental issue, affecting many individuals. It occurs when the protective enamel of teeth wears away, exposing the sensitive dentin beneath [(Aguiar et al., 2017)](https://paperpile.com/c/W6DRcv/3a3qN). Manufacturers have responded by creating specialized toothpaste for this problem. This study explores the effects of two such toothpaste products designed for dentinal sensitivity [(Camargo et al., 2017)](https://paperpile.com/c/W6DRcv/nrdTX).The article employs an "In Vitro" approach, meaning the research takes place in a controlled laboratory setting, rather than within living organisms [(*Compendium of Continuing Education in Dentistry*, 2004)](https://paperpile.com/c/W6DRcv/xraOb). It involves selecting two different toothpaste products for dentinal sensitivity and subjecting dental samples to these products under controlled conditions. Parameters like surface roughness are measured before and after exposure to these toothpaste formulations [(Aguiar et al., 2017; Jamwal et al., 2023)](https://paperpile.com/c/W6DRcv/jSW49+3a3qN).Surface roughness is crucial because it can impact dental health by facilitating plaque and bacteria buildup [(Aguiar et al., 2017)](https://paperpile.com/c/W6DRcv/3a3qN). By assessing the surface roughness of dental samples after using these toothpaste products, the study aims to determine their effectiveness in maintaining or improving tooth surface smoothness.The study's findings, as discussed in the article, provide insights into how these toothpaste products compare in terms of their impact on surface roughness. If one product is found more effective at reducing roughness without harming tooth structure, it could be a significant benefit for those with dentinal sensitivity [(AlShehri et al., 2023)](https://paperpile.com/c/W6DRcv/PXVUb). Such products may offer a practical solution for managing sensitivity while maintaining oral health [(de Lima et al., 2022)](https://paperpile.com/c/W6DRcv/HSvKJ).The findings of this study provide valuable insights into the impact of desensitizing toothpastes on post-brushing roughness, highlighting the intricate balance between effective cleaning and enamel preservation. The comparison between Colgate Sensitive and Sensodyne demonstrated that both toothpastes, while formulated to alleviate dentinal sensitivity, exhibit different effects on tooth surface roughness. These differences suggest that even within the category of desensitizing toothpastes, variations in formulation can significantly influence the tactile perception of the tooth surface post-brushing. The results underscore the necessity for dental professionals to consider these nuances when recommending toothpastes to patients with sensitive teeth, ensuring both effective sensitivity management and minimal enamel abrasion.Dental professionals often recommend toothpaste for patients with dentinal sensitivity. Therefore, the study's results are clinically relevant [(Midha et al., 2021)](https://paperpile.com/c/W6DRcv/wbyTM). If one of these toothpaste products proves to be superior in reducing surface roughness without causing harm, it may become a preferred choice for dental practitioners and patients [(Alsubhi et al., 2021)](https://paperpile.com/c/W6DRcv/yzfBr).The article might also suggest areas for future research. For instance, it may propose studying the long-term effects of these toothpaste products on dentinal sensitivity, conducting clinical trials to validate the findings, or exploring other factors that could influence their performance [(Lima et al., 2020)](https://paperpile.com/c/W6DRcv/7jZFM).In summary, this article contributes valuable insights into the comparison of toothpaste formulations for dentinal sensitivity(Rafi et al., 2024). Through an In Vitro study measuring their impact on surface roughness, it adds to our knowledge of dental care, potentially leading to improved recommendations for individuals with sensitive teeth and promoting better oral health (Tuluwengjiang et al., 2024).The study also brings to light the crucial role of abrasive components in toothpaste formulation. Abrasives are essential for removing plaque and stains, but their presence must be carefully controlled to avoid contributing to enamel erosion and increased surface roughness.[(Vranić et al., 2004)](https://paperpile.com/c/W6DRcv/NJe5) The low abrasivity scores would indicate their suitability for preventing enamel damage, yet the observed differences in post-brushing roughness suggest that other ingredients, such as fluoride and additional desensitizing agents, also play significant roles[(Hamza et al., 2022)](https://paperpile.com/c/W6DRcv/Y5Ib). These findings highlight the complexity of toothpaste formulation and the need for ongoing research to identify the specific contributions of various components to overall tooth surface texture and sensitivity relief.Furthermore, the study emphasizes the importance of proper brushing techniques and oral hygiene practices in conjunction with the use of desensitizing toothpastes. While the formulation of the toothpaste is critical, the manner in which it is used also significantly impacts post-brushing roughness and overall oral health.[(Dionysopoulos et al., 2023)](https://paperpile.com/c/W6DRcv/NoZz) Educating patients on the use of soft-bristled toothbrushes, gentle brushing motions, and thorough rinsing can help mitigate the sensation of roughness and enhance the effectiveness of desensitizing toothpastes.

# Future Scope

The use of the type of brushes were excluded in this study, so next time then can be an inclusion too. The force with which the brushing happens and the pressure for the brushing can be included next time. The sample size can be increased. Future research should explore the synergistic effects of brushing techniques and toothpaste formulations on tooth surface roughness, aiming to develop comprehensive oral care strategies that optimize both sensitivity relief and enamel preservation. This holistic approach can lead to better patient outcomes and improved overall oral health.

# Conclusion

From the above study, a significant correlation was observed between post brushing surface roughness and toothpastes for dentinal sensitivity. Surface roughness produced by brushing may vary with the brushing techniques, forces/pressure exerted, and the degree of abrasion caused by use of dentifrices. Overall, achieving and maintaining smooth tooth surfaces is essential for oral health, hygiene, and aesthetics. Regular dental care, proper oral hygiene practices, and professional dental cleanings can help minimize roughness, prevent plaque accumulation, and maintain a healthy smile.

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