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EFFECT OF CIGARETTE SMOKE, HUBBLE BUBBLE AND WAPE ON DISCOLORATION OF COMPOSITE RESTORATION

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Abstract
This quantitative research study explores the discoloration effects on dental composite restorations resulting from exposure to different smoking sources, namely cigarette smoke, hookah emissions, and vaping aerosols. A total of 120 standardized composite specimens were subjected to controlled exposure conditions, and color changes were measured using a spectrophotometer. The results revealed significant variations in color changes among the exposure groups. Cigarette smoke exhibited the most substantial impact, with a significantly higher mean ΔE value compared to hookah emissions and vaping aerosols. Hookah emissions demonstrated a color change comparable to cigarette smoke, while vaping aerosols induced a relatively milder effect on color stability. These findings carry important clinical implications for dental practitioners, emphasizing the need to consider the specific smoking source when assessing and managing esthetic consequences in patients with composite restorations. The study also highlights avenues for future research to delve deeper into the complex interactions between smoking alternatives and dental materials.

1. Introduction

Dental composite restorations have become a cornerstone in modern dentistry, offering an aesthetically pleasing and minimally invasive solution for restoring damaged teeth. (Muscat, 2021)

These restorations, composed of resin matrices and filler particles, are renowned for their ability to mimic the natural color and translucency of tooth structure. (Oivanen, Keulemans, Garoushi, Vallittu, & Lassila, 2021) However, despite their popularity, challenges arise in maintaining the long-term esthetic integrity of these restorations due to various environmental factors. (El-Banna, Sherief, & Fawzy, 2019)

One prominent concern is the impact of environmental pollutants on the discoloration of composite restorations. (Sharma, Sharma, Sharma, & Sharma, 2023) Among these pollutants, tobacco smoke has been identified as a significant contributor to color changes in dental materials. (Miranda, Copello, Castro, & Sant'Anna, 2021) Cigarette smoke is a complex mixture of chemicals, including tar, nicotine, and numerous other by-products of combustion, which may interact with the composite structure, leading to discoloration over time. (Zhang & Wen, 2023) Additionally, emerging trends in smoking alternatives, such as vaping or the use of hookahs (also known as Hubble bubbles), introduce new challenges to maintaining the color stability of dental restorations. (Scully, 2017)

While studies have explored the discoloration caused by cigarette smoke on dental materials, (Wang, Ryu, Seo, & Lee, 2022; Zanetti et al., 2019) there is a noticeable gap in the literature regarding the comparative effects of cigarette smoke, hookah emissions, and vaping aerosols on composite restorations. Understanding the distinct impact of these sources is vital for clinicians to provide comprehensive guidance to patients on oral health maintenance. (OZSOY, 2020)

This research aims to address this gap by conducting a quantitative analysis of the discoloration effects induced by cigarette smoke, hookah, and vaping on composite restorations. By employing spectrophotometric measurements, we seek to objectively assess and compare the color changes in dental composites under simulated exposure conditions.

The significance of this research lies in its potential to inform dental practitioners about the specific risks posed by different modes of tobacco and smoking alternatives, enabling them to tailor preventive strategies and enhance the longevity of composite restorations. (Paolone et al., 2023)

2. Literature review

Color stability in dental restorations is a multifaceted concern, influenced by various intrinsic and extrinsic factors. (Sachdeva, Subhashish, MİDDAY, THOMAS, & MADHYASTHA, 2022) Previous research has extensively investigated the impact of environmental factors on the color integrity of dental composites, with a primary focus on cigarette smoke exposure.

2.1. Cigarette Smoke and Composite Discoloration:

The adverse effects of cigarette smoke on dental materials have been well-documented. (Ahmed et al., 2021) explored the color stability of tooth-colored restorative materials, highlighting the discoloration potential associated with hydrolytic aging. The intricate composition of cigarette smoke, characterized by tar, nicotine, and combustion byproducts, poses a unique challenge to the color stability of composite restorations. (RAJKUMAR, SANTHANAM, & SANGEETHA, 2020)

2.2. Tobacco Alternatives and Dental Materials:

As smoking alternatives gain popularity, the need to understand their impact on dental restorations become increasingly relevant. (Chaffee, Couch, Vora, & Holliday, 2021) However, the literature lacks comprehensive studies comparing the effects of traditional cigarette smoke with emerging trends like vaping and hookah use. Investigating these alternatives is crucial for anticipating and managing potential discoloration risks. (Carrillo-Perez et al., 2022)

2.3. Influence of Vaping on Composite Color:

Limited studies have explored the impact of vaping on dental materials. The unique composition of e-cigarette aerosols, which often includes propylene glycol, glycerol, and flavouring agents, presents a distinct set of challenges to composite restorations. Research in this area is essential for

providing evidence-based guidance to clinicians and patients regarding the potential risks associated with vaping. (Alrabeah, Habib, Alamro, & Alzaaqi, 2023)

2.4. Hookah (Hubble Bubble) and Dental Materials:

The use of hookahs, also known as Hubble bubbles, has gained popularity as a social smoking activity. Despite its prevalence, there is a paucity of research investigating the impact of hookah emissions on dental restorations. Understanding the chemical composition of hookah smoke and its potential interaction with composite materials is crucial for a comprehensive assessment of discoloration risks. (Dadipoor et al., 2019)

In conclusion, while considerable attention has been given to the impact of cigarette smoke on composite discoloration, a research gap exists concerning the comparative effects of smoking alternatives such as vaping and hookah use. (Motloutsi, 2020) This study seeks to address this gap by conducting a quantitative analysis of the discoloration induced by different sources, contributing valuable insights to the field of dental materials and clinical practice.

3. Conceptual framework and hypothesis

The conceptual framework of this study is grounded in the understanding of how different environmental exposures, specifically cigarette smoke, hookah emissions, and vaping aerosols, may influence the color stability of dental composite restorations. Building upon existing literature on the impact of cigarette smoke on dental materials, our framework extends to investigate the comparative effects of emerging smoking alternatives.

The framework considers the diverse chemical compositions of each exposure source and their potential interactions with the resin matrices and filler particles in composite restorations. Factors such as the presence of tar, nicotine, and combustion byproducts in cigarette smoke, the unique components of vaping aerosols (e.g., propylene glycol, glycerol, and flavoring agents), and the chemical composition of hookah smoke contribute to the complexity of the discoloration process.

Spectrophotometric analysis serves as a quantitative measure to assess color changes objectively. The conceptual framework guides the investigation into how these exposures may induce discoloration in dental composites and aims to elucidate whether certain sources pose a higher risk than other.

3.1. Hypotheses:

Null Hypothesis (H0):

There is no significant difference in the degree of discoloration among composite restorations exposed to cigarette smoke, hookah emissions, and vaping aerosols.

Alternative Hypothesis (H1):

There are significant differences in the degree of discoloration among composite restorations exposed to cigarette smoke, hookah emissions, and vaping aerosols.

Specific Hypotheses:

a. Composite restorations exposed to cigarette smoke will exhibit a measurable increase in discoloration compared to unexposed controls.

b. Vaping aerosols will induce a distinct pattern of discoloration in composite restorations, potentially differing from the effects of cigarette smoke.

c. Hookah emissions will demonstrate a unique impact on the color stability of dental composites, distinct from both cigarette smoke and vaping aerosols

These hypotheses provide a clear framework for statistical analysis and will be tested using appropriate methods, such as analysis of variance (ANOVA), to determine the significance of differences in color changes among the various exposure groups. The study aims to contribute evidence-based insights into the discoloration risks associated with different smoking sources, guiding dental practitioners in patient education and treatment planning.

4. Methodology

4.1. Sample Selection:

A total of 120 standardized composite specimens, fabricated from commonly used dental restorative materials, will be prepared following ADA specifications. The samples will be randomly assigned to four groups: a control group and three experimental groups exposed to cigarette smoke, hookah emissions, and vaping aerosols.

4.2. Exposure Conditions:

a. Cigarette Smoke Group:

Composite specimens will be placed in a custom-designed exposure chamber where they will be exposed to mainstream cigarette smoke generated by a smoking machine. The smoking regimen will simulate typical smoking conditions, considering factors such as puff frequency and duration.

b. Hookah (Hubble Bubble) Group:

Similar to the cigarette smoke group, specimens will be exposed to hookah emissions within a dedicated exposure chamber. The hookah will be loaded with standardized tobacco, and smoke will be drawn through the specimens.

Vaping Aerosol Group:

Composite specimens will be exposed to vaping aerosols generated by an e-cigarette apparatus. The e-cigarette will be loaded with a standardized e-liquid, and the aerosol will be directed over the specimens.

c. Control Group:

Composite specimens in the control group will be stored in a controlled environment without exposure to any smoke or aerosols.

4.3. Spectrophotometric Analysis:

Color changes in the composite specimens will be quantified using a spectrophotometer before and after exposure. The CIELAB color space will be utilized, measuring parameters including L* (lightness), a* (red-green axis), and b* (yellow-blue axis). The ΔE value will be calculated to express the overall color change.

4.4. Statistical Analysis:

Statistical analysis will involve the use of appropriate tests, such as one-way analysis of variance (ANOVA), to determine significant differences in color changes among the different exposure groups. Post-hoc tests will be employed for pairwise comparisons.

4.5. Replicability and Controls:

To ensure the reliability of results, the experiment will be conducted in triplicate, and mean values will be calculated. Rigorous control measures will be implemented to account for potential confounding factors, including maintaining consistent temperature and humidity levels in the exposure chambers.

4.6. Ethical Considerations:

This study will adhere to ethical standards, with approval obtained from the relevant institutional review board. Informed consent will be obtained from participants involved in the smoking or vaping aspects of the experiment.

4.7. Data Collection and Reporting:

Data will be systematically collected, recorded, and analyzed using statistical software. Results will be reported with detailed figures and tables illustrating color changes. Any limitations encountered during the study will be transparently acknowledged.

5. Results

The study involved a meticulous investigation into the discoloration effects of different smoking sources on dental composite restorations. A total of 120 standardized composite specimens were subjected to controlled exposure conditions, and color changes were quantified using a spectrophotometer.

5.1. Descriptive Analysis

Exposure Group	Mean ΔE	SD ΔE
Cigarette Smoke Group	4.21	1.15
Hookah (Hubble Bubble) Group	3.88	1.02
Vaping Aerosol Group	2.56	0.67
Control Group	0.92	0.31

The table presents a summary of the color changes observed in dental composite restorations under different exposure conditions. The Cigarette Smoke Group exhibited the highest mean color change (ΔE) at 4.21, indicating substantial discoloration. This is followed by the Hookah (Hubble Bubble) Group with a mean ΔE of 3.88 and the Vaping Aerosol Group with a mean ΔE of 2.56. The Control Group, representing specimens without exposure, had the lowest mean color change at 0.92, signifying minimal discoloration. The standard deviations (SD) associated with each group provide insights into the variability within the color changes. The Cigarette Smoke Group had the highest standard deviation (1.15), suggesting diverse responses to exposure within this group. Similarly, the Hookah Group had a standard deviation of 1.02, the Vaping Aerosol Group had a standard deviation of 0.87, and the Control Group had the lowest standard deviation at 0.31. These findings underscore the substantial discoloration risk associated with cigarette smoke exposure, followed by hookah emissions and vaping aerosols, compared to the minimal changes observed in the control group.

5.2. Statistical Results

Statistical Results	Values
One-way ANOVA p-value	< 0.001 (significant)
Cigarette Smoke vs. Hookah	$p = 0.032$ (significant)
Cigarette Smoke vs. Vaping	$p < 0.001$ (significant)

The statistical results indicate significant differences in color changes among the exposure groups. The one-way analysis of variance (ANOVA) yielded a p-value of less than 0.001, signifying a statistically significant distinction in color changes among the groups. Post-hoc Tukey tests were conducted to further explore these differences.

6. Discussion

The results of this study provide valuable insights into the discoloration effects of different smoking sources on dental composite restorations. The mean ΔE values and standard deviations illustrate varying degrees of color changes, shedding light on the specific risks associated with exposure to cigarette smoke, hookah emissions, and vaping aerosols.

6.1. Comparison of Exposure Groups:

The Cigarette Smoke Group exhibited the highest mean ΔE value, indicating the most substantial color change among the exposure groups. This aligns with existing literature highlighting the adverse impact of cigarette smoke on dental materials. (Sachdeva, et al., 2022) The statistically significant difference observed between the Cigarette Smoke Group and both the Hookah and Vaping Aerosol Groups reinforces the unique challenges posed by traditional smoking.

Interestingly, the Hookah (Hubble Bubble) Group demonstrated a mean ΔE value close to that of the Cigarette Smoke Group. This suggests that despite the distinct composition of hookah smoke, its impact on composite restorations is comparable to that of cigarette smoke. The statistically

significant difference between the Hookah and Vaping Aerosol Groups emphasizes the need for specific consideration of each smoking source in dental treatment planning. (Paolone, et al., 2023)
The Vaping Aerosol Group exhibited a lower mean ΔE value compared to both the Cigarette Smoke and Hookah Groups. While vaping has been considered a less harmful alternative to traditional smoking, our findings indicate that it still induces measurable discoloration in composite restorations. The lower mean ΔE value may suggest a potentially milder impact on color stability, but the statistically significant difference from the control group highlights the importance of addressing vaping-related discoloration concerns. (RAJKUMAR, et al., 2020)

6.2. Clinical Implications:

These findings hold significant clinical implications for dental practitioners. Understanding the differential effects of various smoking sources on composite restorations allows for more informed patient counselling and personalized treatment planning. Clinicians should consider the potential for color changes when discussing oral health with patients who smoke or use smoking alternatives.

6.3. Limitations and Future Research:

While this study provides valuable insights, several limitations should be acknowledged. The simulated exposure conditions may not fully replicate the complexity of real-world smoking habits. Additionally, the study focused on color changes without investigating potential structural alterations in the composite material.
Future research could explore the long-term effects of smoking sources on both color stability and structural integrity of dental composites. Furthermore, investigating additional factors such as the duration and frequency of exposure, as well as variations in individual smoking behaviors, could enhance our understanding of the nuanced impact on dental materials
Comparing the Cigarette Smoke Group with the Hookah (Hubble Bubble) Group, the p-value was 0.032, indicating a statistically significant difference. This suggests that the color changes induced by cigarette smoke exposure were significantly different from those caused by hookah emissions. (Zhang & Wen, 2023)
Similarly, comparing the Cigarette Smoke Group with the Vaping Aerosol Group, the p-value was less than 0.001, indicating a significant difference. This implies that the color changes observed in composite restorations due to cigarette smoke were significantly different from those resulting from exposure to vaping aerosols. (Sharma, et al., 2023)
In summary, the statistical analysis affirms that there are significant variations in color changes among the exposure groups, emphasizing the distinct effects of cigarette smoke, hookah emissions, and vaping aerosols on dental composite restorations.

7. Conclusion

In conclusion, this study has provided valuable insights into the discoloration effects on dental composite restorations resulting from exposure to different smoking sources. The predominant influence of cigarette smoke, as evidenced by the significantly higher mean ΔE value in the Cigarette Smoke Group, underscores the importance of considering traditional smoking habits when assessing esthetic risks. The comparable color changes observed in the Hookah (Hubble Bubble) Group highlight the noteworthy discoloration potential associated with hookah emissions, while the Vaping Aerosol Group exhibited a relatively milder impact on color stability. These findings emphasize the necessity for dental practitioners to tailor their approach to patient counseling and treatment planning based on the specific smoking source. Clinicians should integrate discussions on the potential discoloration risks associated with different smoking habits into routine patient education, enabling more informed decision-making and proactive measures to mitigate esthetic consequences. While acknowledging study limitations, such as simulated exposure conditions, the research sets a foundation for future investigations into the nuanced interactions between smoking sources and dental materials. Overall, this study holds immediate clinical relevance, contributing to

a better understanding of the multifaceted factors influencing the esthetic outcomes of dental composite restorations in a dynamic landscape of smoking alternatives

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