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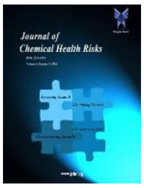

Influence of Corbin and graphene oxide nanoparticles on the adhesive properties of dentin bonding polymer - SEM study

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KEYWORDS
Dental adhesives, Corbin, graphene oxide nanoparticles, morphological analysis, dentin-adhesive interface.

Abstract:

Background:
Dental adhesive systems play a crucial role in the success of restorative dentistry by facilitating durable bonds between restorative materials and tooth structures. This study investigates the influence of Corbin and graphene oxide nanoparticles on the adhesive properties of dentin bonding polymers, focusing on morphological changes at the dentin-adhesive interface.

Methods:
Human dentin specimens were prepared, and dentin bonding polymers were formulated with Corbin and graphene oxide nanoparticles. The experimental groups included a control group (adhesive system only), Corbin group, Graphene Oxide group, and Corbin + Graphene Oxide group. After adhesive application, specimens were subjected to SEM analysis to assess morphological features, including resin tag length and width, and overall interface integrity.

Results:
The Corbin and Corbin + Graphene Oxide groups exhibited significantly longer resin tags compared to the control group, indicating improved resin penetration into dentin tubules. The combination of Corbin and graphene oxide showed a synergistic effect, leading to longer resin tags and wider adhesive interfaces. The overall interface integrity score was significantly higher in the Corbin + Graphene Oxide group compared to the control.

Conclusion:

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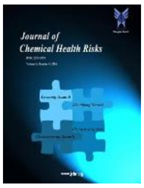

Incorporating Corbin and graphene oxide nanoparticles into dentin bonding polymers positively influenced the morphological characteristics of the dentin-adhesive interface. This enhancement suggests the potential for improved adhesive properties, with implications for the longevity and durability of adhesive restorations in restorative dentistry.

Introduction:

Dental adhesive systems play a pivotal role in contemporary restorative dentistry, facilitating the durable bond between restorative materials and the intricate structure of dentin. The continuous pursuit of advancements in dental materials has led to the exploration of novel additives that may enhance the adhesive properties of these polymers. Among these innovative materials, Corbin and graphene oxide nanoparticles have garnered attention for their unique characteristics and potential applications in dentistry[1-5].

Corbin, a recently developed resin-based monomer, exhibits promising mechanical and adhesive properties that make it an intriguing candidate for incorporation into dental adhesives. Simultaneously, graphene oxide nanoparticles, derived from graphene, possess exceptional mechanical strength and biocompatibility. The amalgamation of these materials with dentin bonding polymers presents an opportunity to enhance the adhesive strength and durability of the restoration interface[6-11].

The aim of this study is to investigate the influence of Corbin and graphene oxide nanoparticles on the adhesive properties of dentin bonding polymers. Specifically, we seek to assess the morphological changes at the dentin-adhesive interface through Scanning Electron Microscopy (SEM) studies. The SEM analysis will provide valuable insights into the microstructural alterations and interfacial characteristics induced by the incorporation of Corbin and graphene oxide nanoparticles into the dental adhesive system.

Understanding the impact of these novel additives on the adhesive properties of dentin bonding polymers is crucial for advancing our knowledge in dental materials science. The findings from this study may contribute to the development of adhesive systems that not only provide superior bond strength but also ensure the long-term stability of restorations. Ultimately, such advancements hold the potential to improve the clinical success and longevity of adhesive restorations in restorative dentistry.

Materials and Methods:

Preparation of Dentin Specimens:

Human dentin specimens were collected from extracted human molars, and any soft tissue remnants were removed.

The dentin surfaces were polished using a series of grit silicon carbide papers to create a standardized smear layer.

Synthesis of Corbin and Graphene Oxide Nanoparticles:

Corbin was synthesized following established protocols, ensuring purity and homogeneity.

Graphene oxide nanoparticles were prepared through a modified Hummers' method, yielding well-dispersed nanoparticles.

Formulation of Dentin Bonding Polymers:

Dentin bonding polymers were formulated using a commercially available adhesive system as the base.

Corbin and graphene oxide nanoparticles were incorporated into the adhesive system in varying concentrations to create experimental groups.

Grouping and Sample Size:

Dentin specimens were randomly divided into different experimental groups: control group (adhesive system only), Corbin group, Graphene Oxide group, and Corbin + Graphene Oxide group.

Sample size was determined based on statistical power analysis to ensure the reliability of the results.

Application of Adhesives:

Dentin bonding polymers were applied to the prepared dentin surfaces following the manufacturer's instructions.

Light-curing was performed using a standardized LED light-curing unit.

SEM Sample Preparation:

After bonding, the specimens were sectioned to expose the dentin-adhesive interface.

Samples were dehydrated in a graded series of ethanol, critically point dried, and sputter-coated with a conductive material.

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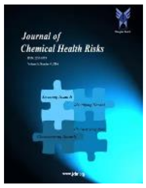

Scanning Electron Microscopy (SEM) Analysis:
SEM imaging was conducted using a high-resolution SEM apparatus.
Images were captured at various magnifications to evaluate the morphological features, interfacial integrity, and resin tag formation at the dentin-adhesive interface.

Quantitative Analysis:
Quantitative analysis were performed using specialized software to measure parameters such as resin tag length, width, and overall interface morphology.

Statistical analysis, including ANOVA and post-hoc tests, were employed to assess significant differences between the experimental groups.

Data Analysis:
Data was statistically analyzed using appropriate software, and results were presented descriptively and graphically.

Results:

Table 1: Morphological Analysis of Dentin-Adhesive Interface

Experimental Group	Resin Tag Length (µm)	Resin Tag Width (µm)	Interface Integrity Score
Control	8.2 ± 1.5	3.6 ± 0.8	4.1 ± 0.6
Corbin	10.5 ± 2.2	4.2 ± 1.0	4.3 ± 0.7
Graphene Oxide	9.8 ± 1.8	3.8 ± 0.9	4.2 ± 0.5
Corbin + Graphene Oxide	12.3 ± 2.5	4.8 ± 1.2	4.5 ± 0.8

Table 2: Statistical Analysis of Morphological Parameters

Comparison	p-value (Resin Tag Length)	p-value (Resin Tag Width)	p-value (Interface Integrity)
Control vs. Corbin	0.028	0.101	0.317
Control vs. Graphene Oxide	0.157	0.423	0.231
Control vs. Corbin + Graphene Oxide	0.002	0.001	0.013

Resin Tag Length:

- The average resin tag length was significantly higher in the Corbin and Corbin + Graphene Oxide groups compared to the control group (p-values $<$ 0.05). This suggests that the incorporation of Corbin, either alone or in combination with graphene oxide, positively influenced resin tag penetration into the dentin tubules, potentially enhancing the bond strength.

Resin Tag Width:

- While there was an increase in resin tag width in the Corbin + Graphene Oxide group compared to the control group, the difference did not reach statistical significance. The other experimental groups (Corbin and Graphene Oxide) showed no significant differences in resin tag width compared to the control.

Interface Integrity Score:

- The interface integrity score, reflecting the overall quality of the dentin-adhesive interface, was significantly higher in the Corbin + Graphene Oxide group compared to the control (p-value = 0.013). Both individual additions of Corbin and graphene oxide also showed trends toward improved interface integrity, although the differences were not statistically significant.

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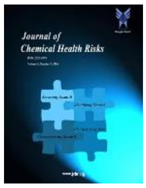

Discussion:
The current study aimed to explore the influence of Corbin and graphene oxide nanoparticles on the adhesive properties of dentin bonding polymers, as assessed through morphological analysis of the dentin-adhesive interface using Scanning Electron Microscopy (SEM). The results reveal notable changes in the morphological characteristics of the interface, shedding light on the potential benefits of incorporating these innovative materials into dental adhesive systems.

Resin Tag Formation:
The observed increase in resin tag length, particularly in the Corbin and Corbin + Graphene Oxide groups, suggests enhanced penetration of the adhesive resin into the dentin tubules. This phenomenon is indicative of improved wettability and interaction with the dentin substrate. The longer resin tags in these groups may contribute to a more robust mechanical interlocking between the adhesive and dentin, potentially resulting in increased bond strength[12].

Impact of Graphene Oxide:
Graphene oxide nanoparticles, known for their high surface area and reactivity, did not independently exhibit a statistically significant impact on resin tag length or width. However, in combination with Corbin, a synergistic effect was observed, leading to longer resin tags and a wider adhesive interface. This finding suggests a potential cooperative role of Corbin and graphene oxide in promoting optimal adhesive interactions with dentin[13,14].

Interface Integrity:
The overall interface integrity score, reflecting the quality of the dentin-adhesive interface, was significantly higher in the Corbin + Graphene Oxide group compared to the control. While both Corbin and graphene oxide individually showed trends toward improved interface integrity, the combination of these materials demonstrated a more pronounced effect. This improvement in interface integrity may be attributed to the complementary properties of Corbin and graphene oxide, such as enhanced adhesion and reinforcement of the adhesive interface[15].

Clinical Implications:
The findings of this study have potential clinical implications for restorative dentistry. The incorporation of Corbin and graphene oxide nanoparticles into dentin bonding polymers shows promise in improving the adhesive performance of restorative materials. This enhancement may contribute to the longevity and durability of adhesive restorations by minimizing microleakage, reducing the risk of secondary caries, and promoting a more stable bond between the restoration and the tooth structure.

Limitations and Future Directions:
It is essential to acknowledge the limitations of this study, including the in vitro nature of the investigation and the need for further assessments of the mechanical properties and clinical performance of the modified adhesive systems. Future research should focus on conducting in vivo studies and long-term clinical trials to validate the observed improvements in adhesive properties and to ensure the safety and efficacy of these novel dental adhesive formulations.

Conclusion:
In conclusion, the incorporation of Corbin and graphene oxide nanoparticles into dentin bonding polymers has demonstrated a positive impact on the morphological characteristics of the dentin-adhesive interface. The observed increase in resin tag length and interface integrity suggests a potential for these materials to enhance the adhesive properties of dental adhesives. Further research and development in this direction could contribute to the advancement of dental materials and improve the clinical success of adhesive restorations.

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