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Coatings for Dental Materials: How They Affect Clinical Performance

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Abstract: Contemporary dentistry embraces digital procedures and advanced biomaterials to improve patients' quality of life. As practitioners, we are encouraged to adapt in every aspect of our work, from diagnosis to the creation of prosthetics. The latest biomaterials need to be more damage-tolerant and capable of ensuring longer-lasting results. Consequently, biomimetic replacements, tissue engineering scaffolds, and even cloned teeth could represent the best options for future treatments.

Keywords: coating; ceramic; resin composite; bone healing; roughness.

Introduction

In the intraoral environment, factors such as temperature, pH, electrochemical potential, solute concentrations, and oxygen levels can directly interact with various materials. Therefore, protective layers like glazing and coatings are essential to mitigate the effects of the oral environment on these materials and ensure long-term clinical stability. Clinicians must understand the properties of these materials and how to enhance their mechanical performance in the challenging conditions of the oral cavity (1).

Dental ceramics are commonly used as dependable restorative materials, and the technique used for surface finishing plays a crucial role in influencing cyclic fatigue and the topography of ceramic restorations. Similarly, polished glass ceramics are sensitive to variations in load profiles, highlighting the impact of surface morphology on fatigue resistance. A notable protective effect on the chemical solubility of a glass ceramic in various pH environments can be observed when a protective coating is applied to its surface. Thus, it would be valuable to determine whether different restorative materials exhibit similar behavior or if alternative coating materials might yield different results (2).

In addition to environmental factors, surface defects can occur due to clinical and laboratory procedures, regardless of how the manufacturer processes the material. In this context, if the topographical defects created during surface treatments are filled with composite cement during the luting process, the material's strength can be enhanced. Conversely, if these defects are not fully filled with composite cement, the fatigue performance of the ceramic restorations may suffer due to high stress concentrations within these defects during load application (3).

However, we should avoid recommending or implementing less aggressive surface treatments solely to minimize the number of material defects, as this could adversely affect the bond strength of the restoration and ultimately reduce its longevity. Therefore, the literature continues to search for a protocol that balances optimal bond strength with minimal alterations to the material structure and ensures long-term reliability (4).

The wear rate of indirect materials is influenced not just by the microstructure, but also by the application of shade characterization layers and glazing as coatings on their surfaces. Regardless of the mechanical properties of the materials, the durability of the extrinsic staining layer will be affected by the amount of glass phase present in the restorative material. Furthermore, for hybrid materials that require polymeric coatings, surface treatment is essential to enhance their longevity. However, the literature has yet to explore the wear rate and material performance following the removal of glazing and shade layers. Additionally, the superficial topography of the material or coatings, characterized by low roughness and sufficient homogeneity, may also play a role in bacterial adhesion and human cell viability. Consequently, both laboratory and clinical modifications will impact not only the mechanical properties of dental materials but also their biological responses (5).

In terms of direct restorative procedures, enhancing the dissipation of chewing load, reducing polymerization residual stress, and preventing microleakage can be achieved through the use of coatings with a functional layer. These coatings can improve the performance of restorations by altering the wettability of polymers. Polymeric biomaterials used in dental applications can also serve as coatings for both direct and indirect restorations, allowing for the deposition of nanoparticles within their structure. This method can influence the film thickness and mechanical properties of the polymeric biomaterials, leading to new applications and treatment options. When using temporary materials such as glass ionomer cements, adding a protective coating helps stop moisture from damaging the material, reduces leaks around the gums, and improves the strength of the restoration (6).

Nowadays, resin-based coatings are also used to lower water absorption, prevent the material from dissolving, and avoid color changes. This means temporary materials can last longer when necessary, making dental treatments easier for both dentists and patients. In the field of dental implants, there has been a significant increase in surface modifications and coatings using various materials and biomolecules over the past 20 years, aimed at enhancing bone interaction (7). Examples of these modifications include improvements in bone healing, osseointegration, and corrosion resistance, all of which can be achieved through appropriate coatings. Additionally, alternative processing methods such as additive manufacturing and technologies like microwave heating can alter the mechanical properties of modern dental materials. These advancements may even lead to the creation of smart materials and coating layers that enhance the reliability and outcomes of dental treatments (2).

Today, it's very important to choose the best biomaterials for each treatment and to carefully manage both clinical and lab settings to make sure our treatments work as well as possible. We must always think about the patient's general health. To make new materials better in terms of strength and how they interact with the body, we need to use special surface treatments and coatings. Research in dental materials should follow this method to improve the quality of the materials we use.

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