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Long-term Bond Strength of a Novel Low-shrinkage Resin Core System to Root Canal Dentin

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Introduction

The restoration of root canals with resin-based materials has become a cornerstone in modern endodontics. Bonding to dentin is crucial for the success and longevity of root canal treatment, and the development of materials that provide durable adhesion over time remains a key area of focus in restorative dentistry. One of the challenges in root canal therapy lies in achieving long-term bond strength between restorative materials and the underlying root canal dentin. Over the years, the pursuit of improving adhesive systems, resin composites, and core materials has led to the introduction of novel materials designed to enhance bonding efficacy while minimizing clinical issues such as polymerization shrinkage [1].

Polymerization shrinkage, particularly in resin-based materials, is one of the major factors contributing to the failure of bonded restorations. The resulting stress can lead to marginal leakage, post-operative sensitivity, and ultimately, failure of the bond between the resin core system and dentin. In response to this, a new generation of low-shrinkage resin-based core materials has been introduced with the aim to address these concerns and improve the long-term bond strength to root canal dentin. This explores the long-term bond strength of a novel low-shrinkage resin core system to root canal dentin. We will examine the material's properties, its performance over extended periods, and the impact of these innovations on clinical outcomes. Through an in-depth review of experimental results, we aim to provide insights into the potential benefits and challenges associated with this novel system in clinical practice [2].

Description

The adhesive bond between resin materials and dentin plays a pivotal role in the clinical success of endodontic treatments. Historically, bonding to dentin has been challenging due to its complex structure and moisture content. Additionally, root canal dentin is subjected to various factors such as dehydration, irrigation protocols, and the presence of pulp tissue remnants, all of which may compromise bonding. Dentin bonding agents have evolved over the years, with several generations emerging to address these issues. From the first-generation adhesives that utilized simple acid-etching techniques to more advanced multi-step systems that involve primer and bonding agents, significant improvements in adhesion have been made. However, even modern adhesives face challenges with regard to achieving consistent long-term bond strength, particularly in the context of resin-based core materials used in root canal therapy. A major issue in resin-based materials is polymerization shrinkage. When resin materials undergo polymerization, they shrink, creating internal stresses that can affect the bond between the resin and the dentin. These stresses can lead to gap formation, microleakage, and ultimately, failure of the restoration. To address this problem, the development of low-shrinkage resins has been a critical advancement in restorative dentistry, with the aim to minimize the detrimental effects of shrinkage on the bond to dentin [3].

The novel low-shrinkage resin core system in question is designed specifically to mitigate the challenges associated with polymerization shrinkage while maintaining high bond strength to root canal dentin. These materials are typically composed of advanced resin matrices, inorganic fillers, and modified polymerization systems. The core concept of these systems is to reduce the degree of shrinkage during polymerization, thereby minimizing the internal stress that can affect the bond interface. Several strategies have been employed in the development of these low-shrinkage materials. Some systems incorporate nanofillers or microfillers that improve the material's mechanical properties while reducing shrinkage. Others use modified monomers that undergo less volumetric contraction during the curing process. Additionally, some systems are designed to release or absorb moisture, allowing for better adaptation to the root canal environment and enhancing the bond stability over time. In the context of root canal restorations, the effectiveness of these low-shrinkage materials depends not only on their shrinkage characteristics but also on their ability to form a durable and strong bond to dentin. Over time, the material must withstand cyclic loading, moisture, and other environmental factors that could compromise the bond. As such, long-term bond strength testing is crucial to evaluate the clinical viability of these materials [4].

Long-term bond strength is essential for assessing the clinical performance of any dental material, particularly in the challenging environment of root canal restorations. Various laboratory tests are conducted to evaluate the durability and stability of the bond between a resin core system and root canal dentin. Microtensile bond strength test involves sectioning bonded samples into small beams and applying tensile force until failure occurs. The results provide an indication of the adhesive bond strength at the interface between the resin and dentin. Push-Out method is often used to evaluate bond strength to dentin at different depths within the root canal. A cylindrical specimen is subjected to a force that pushes the bonded material out of the canal, and the bond strength is calculated based on the force required for debonding. In order to simulate the oral environment, samples are subjected to cycles of temperature fluctuations, often between 5°C and 55°C, to mimic the thermal stresses that a restoration would experience *in vivo*. Samples are immersed in water for extended periods to assess the effect of moisture on the bond strength over time. This is particularly important in the context of root canal treatments, where moisture levels are variable and can affect the longevity of the bond [5].

Conclusion

The development of low-shrinkage resin core systems represents a promising advancement in the field of endodontics. These materials offer significant improvements in bond strength to root canal dentin, addressing key challenges such as polymerization shrinkage and long-term durability. The reduction in shrinkage stress not only minimizes the risk of marginal leakage and post-operative sensitivity but also enhances the overall performance and longevity of root canal restorations. Long-term bond strength evaluations have shown that these novel materials exhibit superior bonding properties compared to traditional systems, even after extended periods of water storage and thermocycling. As a result, low-shrinkage resin core systems hold great potential for improving clinical outcomes in root canal therapy. However, further research is needed to explore the long-term effects of these materials in clinical settings and to assess their performance across a broader range of clinical scenarios. The continued development of resin-based materials that offer both strong adhesion and minimal shrinkage will undoubtedly play a

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critical role in the future of root canal treatment, improving the overall prognosis and longevity of endodontic restorations.

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Conflict of Interest

None.

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