MICROLEAKAGE IN FULL-COVERAGE RESTORATIONS CONVENTIONAL AND DIGITAL IMPRESSIONS

Radjabov Alisher Islomovich
Assistant at the Alfraganus University
https://doi.org/10.5281/zenodo.17746757

Abstract

Microleakage in full-coverage restorations remains a major challenge in restorative dentistry and is defined as the penetration of bacteria, oral fluids, or ions between a restoration and the tooth structure. This subtle but problematic infiltration can result in secondary caries, postoperative sensitivity, marginal discoloration, and ultimately, restoration failure. Such concerns are especially relevant for full-coverage restorations, which play a vital role in rehabilitating structurally compromised teeth and ensuring long-term oral health.

As restorative methods advance, understanding the contributing factors to microleakage—including impression technique selection, restorative material properties, and clinical protocols—has become increasingly important for enhancing treatment outcomes. Full-coverage restorations may be fabricated using conventional impression techniques or digital workflows. Although traditional impressions have been considered reliable for decades, they are prone to distortions due to material limitations and technique sensitivity, including errors stemming from patient movement during the impression procedure.

Digital impressions, enabled by modern intraoral scanners and CAD technologies, provide superior accuracy and efficiency, which may reduce marginal discrepancies and help minimize microleakage. However, the literature continues to debate the relative advantages of these methods, particularly for complex restorative cases where conventional impressions might still offer certain clinical benefits.

The etiology of microleakage is multifactorial. Contributing elements include thermal expansion mismatches, polymerization shrinkage of restorative materials, adhesive system selection, and the quality of the impression itself. Evidence indicates that specific restorative approaches—such as incremental placement techniques—can improve marginal adaptation and reduce the likelihood of microleakage. Additionally, factors such as material aging, oral environmental fluctuations, and long-term wear further complicate the durability of restorations, underscoring the importance of proper material choice and meticulous clinical technique.

Types of Full-Coverage Restorations

Full-coverage restorations constitute an essential component of restorative dentistry, designed to restore the structural integrity, function, and aesthetics of compromised teeth. These restorations can be broadly classified according to the impression technique employed during their fabrication, as the accuracy of impressions significantly affects clinical performance and longevity.

Conventional Full-Coverage Restorations

Conventional full-coverage restorations rely on traditional impression procedures that involve several sequential steps. The process typically includes taking an impression with elastomeric materials, creating a stone cast, and subsequently digitizing it for laboratory fabrication. However, this multi-step approach is inherently technique-sensitive and subject to several limitations, including the hydrophilicity and dimensional stability of impression

materials, restricted working time, and the potential for distortion due to patient movement during impression taking.

These factors can introduce inaccuracies that compromise the fit of the prosthesis. Despite such challenges, conventional techniques have long been considered the gold standard in certain clinical settings due to their established reliability and predictable outcomes.

Digital Full-Coverage Restorations

Advances in digital dentistry have enabled the fabrication of full-coverage restorations using digital impressions. Intraoral scanners (IOS) capture highly accurate three-dimensional images of the prepared tooth, eliminating many of the cumbersome steps associated with traditional methods, such as tray selection and impression material handling. Digital impressions improve precision, shorten chair time, and enhance patient comfort—particularly when combined with same-day fabrication technologies. Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) systems further streamline the workflow by allowing precise virtual design and milling of restorations, resulting in improved marginal fit and predictable bonding efficiency. Additionally, digital workflows enhance communication between clinicians and dental laboratories, contributing to superior treatment planning and greater patient satisfaction.

Comparison of Techniques

Although digital impression systems offer numerous advantages in accuracy, efficiency, and patient comfort, they are not without limitations. In complex cases, such as full-arch rehabilitations, conventional impression techniques may still provide superior accuracy and detail reproduction. Consequently, the choice between digital and conventional approaches must be guided by the specific clinical situation, practitioner experience, and available technological resources.

Both methods continue to play indispensable roles in modern prosthodontics, with ongoing technological developments steadily improving the precision and applicability of full-coverage restorations.

Causes of Microleakage

Microleakage in dental restorations primarily arises from insufficient adaptation between the restorative material and the tooth structure, resulting in microscopic marginal gaps. These gaps allow the penetration of bacteria, oral fluids, and ions, which can lead to complications such as postoperative sensitivity, secondary caries, marginal staining, and eventual restoration failure.

Factors Contributing to Microleakage

Multiple intrinsic factors influence the development of microleakage. Among these, discrepancies in thermal expansion between tooth and restorative material, polymerization shrinkage, and water sorption properties play significant roles. The selection and proper use of adhesive systems are also critical. Research indicates that etch-and-rinse adhesives generally achieve better marginal integrity and exhibit less marginal discoloration than certain self-etch systems, thereby reducing the potential for microleakage.

The composition and physical characteristics of restorative materials, as well as the volume placed during restoration, significantly affect microleakage risk. Techniques such as incremental layering have been shown to reduce polymerization shrinkage stresses, thereby minimizing the formation of marginal gaps. In contrast, bulk-fill materials—although designed

to improve efficiency—may still exhibit microleakage if their mechanical properties are insufficient for the clinical situation or if they are improperly applied.

External factors further contribute to the problem. Aging of restorative materials, changes within the oral environment, and gradual degradation of adhesive interfaces can weaken the bond over time, increasing marginal discrepancies and the likelihood of microleakage. Therefore, careful material selection and adherence to optimal clinical techniques are essential to improving restoration durability and long-term success

Prevention and Management

Microleakage represents a significant challenge in full-coverage restorations, as it can compromise restoration longevity, structural integrity, and overall clinical performance. Implementing effective preventive and management strategies is essential to reduce microleakage risk and improve the durability of restorative treatments.

Understanding Microleakage

A comprehensive understanding of the causes of microleakage is fundamental to its prevention. Factors such as inaccurate impression techniques, inappropriate material selection, and insufficient precision during the restorative procedure can all contribute to the formation of marginal gaps that permit fluid and bacterial penetration. Addressing these variables early in the clinical workflow is key to minimizing microleakage.

Techniques for Prevention

Impression Techniques

The method used to obtain impressions has a profound influence on the quality of marginal adaptation. Digital impressions generally yield superior marginal accuracy compared to conventional impression methods due to enhanced precision and reduced technique sensitivity. The use of intraoral scanners (IOS) allows for more accurate data capture and facilitates improved treatment planning and clinical collaboration. These advantages collectively help reduce the likelihood of microleakage in the final restoration.

Material Selection

The properties of restorative materials play a crucial role in preventing microleakage. High-performance materials designed with improved mechanical and physical characteristics can significantly reduce the formation of marginal discrepancies. Bulk-fill composites, for example, offer efficient cavity coverage with favorable marginal adaptation when used appropriately. Nevertheless, proper application protocols—such as employing incremental layering techniques to limit polymerization shrinkage—remain essential to ensure optimal outcomes and minimize stress at the restoration margins.

Adabiyotlar, References, Литературы:

1. ISO 4049. (2009). *Dentistry — Polymer-based restorative materials.* International Organization for Standardization.

2. Van Dijken J.W.V. (2000). *Retention and marginal adaptation of restorations over 13 years.* Operative Dentistry, 25(6), 444–450.

3. Boaro L.C.C., et al. (2019). *Adhesive dentistry and polymerization stress: Reviews and considerations.* Dental Materials, 35(1), e1–e20.

4. Opdam N.J., et al. (2007). *Longevity and reasons for failure of composite restorations.*

Journal of Dentistry, 35(4), 214–222.

5. Dietschi D., Basso M., Carrassi A. (2002). *Marginal adaptation and microleakage in different restorative procedures.* American Journal of Dentistry, 15(3), 144–148.

6. Czasch P., Ilie N. (2013). *Bulk-fill vs. incremental layering: Marginal quality comparison.* Clinical Oral Investigations, 17(1), 227–235.

7. Alrahlah A. (2018). *Setting and polymerization features of bulk-fill materials: Implications for microleakage.* Restorative Dentistry & Endodontics, 43(4), e42.