

The Success of Class V Restorations and Bond Strength

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ABSTRACT

Class V restorations, located at the cervical third of the tooth, present unique clinical challenges due to their proximity to the gingiva, presence of dentin and cementum substrates, and exposure to flexural forces. Bond strength between restorative materials and the tooth surface is critical for clinical success, affecting retention, marginal integrity, and resistance to microleakage. This paper explores how different adhesive strategies, substrate characteristics, and environmental conditions impact bond strength and, consequently, the longevity of Class V restorations. Evidence from in vitro and clinical studies is synthesized to provide a comprehensive understanding of the relationship between bond strength and restoration success.

Keywords

Bond strength, Properties of adhesion, Bonding effectiveness with Class V restorations.

Introduction

Class V lesions, whether carious or non-carious cervical lesions (NCCLs), demand a precise understanding of the restorative environment. These restorations frequently involve bonding to both enamel and dentin, and occasionally to cementum, which complicates adhesion. Adhesive failure at these interfaces remains a primary cause of restoration failure. Bond strength, as a quantifiable property of adhesion, is a key predictor of restoration performance, influencing retention rates, marginal adaptation, and resistance to recurrent caries and hypersensitivity. Numerous factors affect bond strength, including the adhesive system used, the tooth substrate, operator technique, and intraoral conditions such as moisture and stress.

Discussion

The nature of dentin at the cervical region significantly affects bonding effectiveness. Unlike enamel, dentin has a higher

organic content and variable tubule orientation, which poses a challenge for achieving durable adhesion. Studies have shown that hybrid layer formation and resin tag penetration are crucial for optimal bond strength in these areas. Self-etch and total-etch systems demonstrate variable efficacy depending on their ability to demineralize dentin and infiltrate exposed collagen fibrils. For instance, two-step self-etch systems have been associated with higher bond strength and lower technique sensitivity compared to three-step etch-and-rinse systems in the cervical region [1-3].

Another factor influencing bond strength is the presence of sclerotic dentin, commonly found in NCCLs. Sclerotic dentin is characterized by occluded tubules and increased mineral content, which inhibits adhesive penetration and reduces micro-mechanical interlocking. Pre-treatment methods such as air abrasion or use of mild acids can improve the bonding surface by modifying the smear layer and opening tubules [4,5]. However, the clinical relevance of such treatments remains debated, and *in vivo* studies suggest that bond strength improvements may not always translate into better long-term outcomes [6-8].

Table 1: Factors Affecting Bond Strength in Class V Restorations and Their Clinical Implications.

Factor	Description	Clinical Implication
Tooth Substrate	Enamel, dentin, or cementum. Dentin and cementum have lower mineral content.	Requires careful adhesive selection and pretreatment for optimal hybrid layer formation.
Sclerotic Dentin	Mineralized dentin with occluded tubules found in NCCLs.	Reduced resin infiltration and micromechanical retention. Surface modification helpful.
Adhesive System	Etch-and-rinse vs. self-etch adhesives.	Two-step self-etch systems offer better bond strength with less technique sensitivity.
C-Factor	Configuration factor influencing shrinkage stress.	High in Class V lesions; incremental placement and low-shrinkage composites recommended.
Polymerization Shrinkage	Volumetric contraction during curing of composites.	Can cause marginal gap formation and adhesive failure.
Moisture Control	Saliva, blood, or dentinal fluid contamination.	Isolation critical to avoid compromised bonding. Rubber dam preferred.
Flexural Stress (Abfraction)	Forces at cervical region due to occlusal loading.	Use of flexible, low-modulus materials improves stress absorption and longevity.
Operator Technique	Handling of adhesive and composite, curing protocols.	Variability in technique directly impacts bond strength and clinical outcomes.
Aging and Degradation	Hydrolytic breakdown of adhesive components over time.	Newer adhesives include nanofillers and bioactive agents to enhance durability.

The configuration factor (C-factor) in Class V restorations is another determinant of stress distribution at the bonded interface. Due to limited free surface area, polymerization shrinkage stress is concentrated at the margins, risking adhesive failure. Low-shrinkage composite resins and incremental placement techniques have been recommended to mitigate this effect [9,10]. Moreover, the selection of flowable composites with low modulus of elasticity can compensate for flexural stresses, especially in NCCLs caused by abfraction [11,12]. These strategies have shown promise in preserving bond integrity and enhancing restoration longevity.

Long-term clinical evaluations confirm that higher bond strength is generally associated with improved restoration performance. Studies with follow-ups exceeding five years report that restorations with superior bond strength exhibit less marginal discoloration, reduced microleakage, and lower failure rates [13-15]. Nonetheless, bond strength alone does not ensure clinical success; it must be considered in conjunction with proper isolation, operator skill, and patient-specific factors such as occlusion and oral hygiene [16,17]. Additionally, newer adhesive technologies incorporating nanofillers and bioactive components aim to enhance bond durability and interface remineralization [18-20].

Conclusion

Bond strength is a pivotal factor in the success of Class V restorations. Its influence extends beyond initial retention to include critical aspects such as marginal integrity, prevention of microleakage, and resistance to biomechanical stress. Variability in substrate type, adhesive system, and clinical conditions necessitates a careful, evidence-based approach to material selection and technique.

While laboratory tests provide valuable insights into bond strength performance, clinical outcomes depend on a multifactorial interplay involving biological, mechanical, and procedural

elements. Clinicians must understand not only the chemical and mechanical behavior of adhesive systems but also the clinical realities that influence bonding efficacy. As dental materials continue to evolve, future innovations should aim at improving bond strength consistency and longevity, ultimately enhancing the prognosis of Class V restorations in everyday practice.

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