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Restoring the rear guard-the biomimetic approach to posterior teeth

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Abstract
Restorative dentistry has undergone significant advancements over the past century. Traditional approaches often required the removal of excessive healthy tooth structure and relied on rigid restorative materials, which weakened the tooth and reduced the lifespan of restorations. The modern concept of biomimetic restorative dentistry aims to replicate the natural structure and function of the tooth using advanced adhesive techniques. In the present case, a biomimetic protocol was employed to manage deep caries in a vital posterior tooth. The approach involved selective caries removal, immediate dentin sealing, and reinforcement with Ribbond and EverX Flow. The goal of this technique was to maximize bond strength, preserve pulp vitality, maintain a long-term marginal seal, and minimize residual stress. This case illustrates the effectiveness of biomimetic principles in achieving durable and biologically sound restorations.

Keywords: Biomimetic restorative dentistry**,** adhesive techniques**,** pulp preservation fiber-reinforced composites**,** immediate dentin sealing

Introduction
Restorative dentistry has played a crucial role in managing dental caries and structural damage to teeth. Over the years, techniques and materials used in restorative procedures have evolved significantly. Traditional restorative approaches, such as the extension for prevention, involved the removal of not only diseased but also healthy tooth structures. These methods often relied on rigid, non-responsive materials like amalgam and full-coverage crowns, which, despite restoring function, tended to weaken the remaining tooth structure, increasing the risk of fractures and the need for future retreatments [1, 2].

In response to these challenges, biomimetic restorative dentistry has emerged as a modern approach focused on preserving natural tooth structure and mimicking its biological and mechanical properties [3, 4]. Instead of aggressively cutting down tooth material for mechanical retention, biomimetic dentistry emphasizes minimally invasive techniques that utilize advanced adhesive materials to restore teeth while maintaining their natural integrity [5].

The primary goal of biomimetic dentistry is to conserve pulp vitality, enhance the durability of restorations, and reduce the likelihood of secondary caries and fractures [6]. This is achieved through strong adhesive bonds that reinforce the tooth, making it more resistant to mechanical stresses. Additionally, these restorations function similarly to natural teeth by retaining flexibility and improving fracture resistance when the tooth remains hydrated by the pulp [7].

Moreover, advancements in adhesive technology have significantly improved the longevity and effectiveness of biomimetic restorations. By creating a strong hybrid layer between the restorative material and the tooth, these adhesives prevent bacterial microleakage and secondary decay [8, 9]. This approach not only extends the lifespan of restorations but also reduces the need for repeated interventions, ultimately promoting long-term oral health and patient satisfaction [10].

Case Report
A 37-year-old patient reported to the Department of Conservative dentistry and Endodontics with chief complaint of sensitivity in the lower left posterior region.

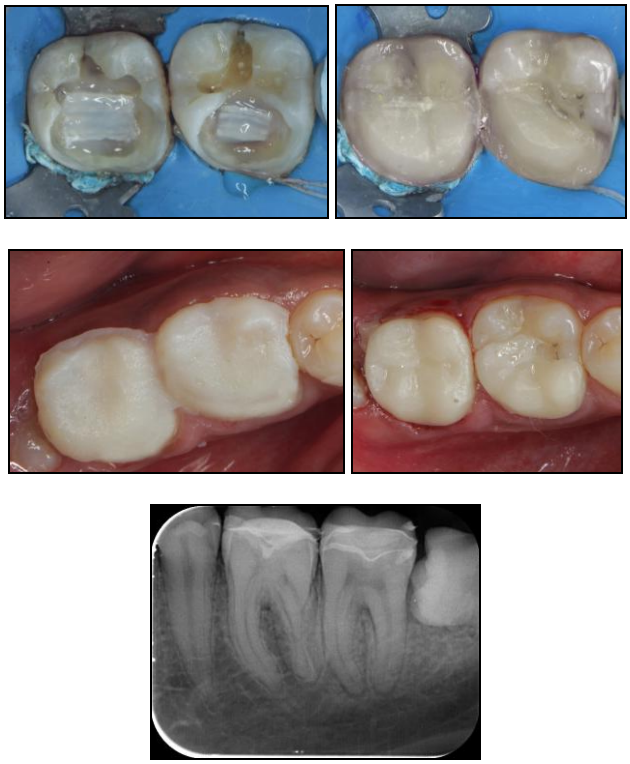
Pulp sensibility testing indicated that the involved tooth was vital. Intraoral periapical radiographic showed enamel and dentin involvement with no pulpal involvement and no periapical pathology.

The affected tooth (36, 37) was anesthetized using 2% lignocaine, followed by rubber dam isolation.

Caries removal was initiated using a Caries Detection Dye (CDD). The dye was applied for 10 seconds and rinsed off to highlight the organic components, serving as a guide for further excavation. Caries were removed progressively from the periphery towards the center, ensuring complete removal from the peripheral seal zone (PSZ). It was advised to avoid caries removal exceeding 5mm occlusally and 3mm near the marginal ridge to preserve structural integrity.

Air abrasion was performed before bonding. The Clearfil SE Bonding System, was applied using a two-bottle self-etch bonding agent as per the manufacturer's instructions. At this stage, the decoupling with time (DWT) commenced. Within the next five minutes, no more than 2mm of composite was added, as the hybrid layer in dentin requires this duration to develop optimal strength, then thin layer of microfilled flowable composite, known as resin coating, was then applied over the dentin, extending slightly beyond the dentinoenamel junction (DEJ). A five-minute waiting period followed to allow the DWT phase to complete. To counteract polymerization shrinkage, Ribbond was placed on the pulpal floor, ensuring composite material was pushed towards the tooth structure rather than away from it.

In the deep central area, where bonding was compromised due to the presence of soft dentin, Ribbond was embedded in a bed of EverX Flow and cured to enhance adhesion. Incremental dentin replacement was carried out, ensuring proper adaptation. As the cusp thickness was less than 2mm, onlay preparation was performed for tooth #36 and overlay preparation for tooth #37. temporization was done for 1week followed by onlay and overlay cementation done with resin cement.



Discussion

The clinical shift from conventional restorative methods to biomimetic restorative dentistry signifies a major advancement in preserving both structural and biological integrity of the tooth. Traditional techniques such as "extension for prevention" often resulted in unnecessary removal of healthy tooth structure, increasing the risk of structural weakening and subsequent restorative failures. In contrast, the biomimetic approach aligns with the principles of minimal intervention dentistry, aiming to emulate the natural form, function, and strength of the tooth while maintaining pulp vitality and maximizing longevity of the restoration [3].

In the presented case, the preservation of the Peripheral Seal Zone (PSZ) played a pivotal role. The PSZ, comprising enamel, dentinoenamel junction (DEJ), and superficial dentin, is critical for achieving long-term adhesion and preventing microleakage. Guided caries removal, facilitated by the use of Caries Detection Dye (CDD)**,** enabled selective excavation, ensuring infected dentin was removed while maintaining sound dentin and enamel. This selective approach aligns with Fusayama's concept of differentiating between infected and affected dentin to avoid unnecessary pulpal exposure [13, 14].

The decision to implement Immediate Dentin Sealing (IDS) using Clearfil SE Bond**,** followed by the resin coating technique, mirrors biomimetic protocols designed to optimize hybrid layer formation and reduce polymerization stress. This two-step self-etch adhesive is well-documented for its reliable bond strength and reduced postoperative sensitivity, supporting clinical success especially in deep dentin areas [5, 15, 16].

The incorporation of Ribbond fibers in areas of compromised dentin, particularly over the pulpal floor and in deep central regions, further exemplifies the stress-reducing philosophy of biomimetic restorations. These polyethylene fibers distribute forces across a wider area, reinforcing the tooth-restoration complex and enhancing fracture resistance. Their use is particularly justified in structurally weakened teeth with thin remaining dentin, as in this case [21, 24, 25].

Additionally, EverX Flow, a short fiber-reinforced composite, was used to build up the deep dentin replacement. This material is known for its superior mechanical properties and ability to limit crack propagation, thus acting as a substitute for lost dentin with enhanced internal stress distribution [22, 23].
Time-controlled "decoupling with time" (DWT) was applied before bulk composite placement. This step is crucial, as the development of the hybrid layer and bond strength is time-dependent. Literature supports that a waiting period of 5-30 minutes after adhesive application can reduce internal stresses by up to 90-95%, leading to improved longevity and reduced marginal gap formation [16, 17].
Further, incremental layering, use of low-shrinkage composites, and controlled polymerization were integrated into the protocol to reduce C-factor and avoid polymerization shrinkage. These practices are consistent with the biomimetic philosophy that aims to maintain internal harmony between the restored structure and the natural tooth mechanics [18-20].
In cases like this, where cusp thickness is compromised (<2 mm), cuspal coverage restorations such as onlays and overlays become necessary. Full cuspal coverage prevents flexure under occlusal load and protects the underlying adhesive interface from degradation [12]. The temporization phase ensured soft tissue and occlusal stabilization before final cementation with resin cement, securing long-term success [10].

Conclusion
This case demonstrates the success of biomimetic restorative dentistry in preserving pulp vitality and tooth structure. Through selective caries removal, immediate dentin sealing, and fiber reinforcement with Ribbond, a durable and minimally invasive restoration was achieved. The approach promotes long-term function and biological integrity compared to conventional methods.

Conflict of Interest
Not available

Financial Support
Not available

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