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Case Report

Biomimetic Semi-Direct Restorations and Secure Bonding with Fibers in Endodontically Treated Premolars: A Case Report

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Abstract: The rehabilitation of endodontically treated teeth is a common clinical challenge that demands a technique capable of preserving the remaining tooth structure while respecting adhesive principles. This report presents the clinical rehabilitation of two maxillary premolars with extensive coronal loss, both previously endodontically treated, one of which had a pre-existing glass-fiber post. Treatment involved maintaining this post and fabricating semi-direct composite resin restorations for both teeth, following the principles of biomimetic dentistry. The case illustrates the clinical applicability of conservative, adhesion-based approaches. The use of semi-direct composite restorations, combined with fiber reinforcement, proved to be a viable and effective alternative for posterior teeth with major structural compromise. We conclude that individualized planning, coupled with strong technical-scientific proficiency, is essential for clinical success in cases of severe coronal rehabilitation.

Keywords: Oral rehabilitation; Composite resin; Semi-direct restoration; Fiber reinforcement.

1. Introduction

Contemporary restorative dentistry continually seeks solutions that combine esthetics, function, and maximal preservation of tooth structure [1]. Advances in adhesive dentistry and minimally invasive restorative techniques have made it possible to rehabilitate compromised teeth more conservatively, particularly those that have undergone endodontic treatment. In such cases, the fragility of the remaining tooth structure, coupled with coronal loss, increases the risk of fracture and demands restorative approaches that provide structural reinforcement and clinical longevity [2].

Among the restorative options for endodontically treated teeth, semi-direct composite resin restorations have gained prominence, especially in situations with substantial structural loss yet sufficient remnant to support an adhesive rehabilitation [3]. Their main advantages include a minimally invasive nature, favorable esthetics, reduced cost, and the possibility of direct repair in the event of failure. Proper selection of the restorative material and adhesive strategies, as well as the use of resources that promote dissipation of masticatory stresses, are fundamental to clinical success [4].

In this context, the use of reinforcing fibers, such as polyethylene fiber (Ribbond), emerges as an efficient strategy to increase fracture resistance in structurally compromised teeth [5]. This material consists of a high–molecular-weight woven polyethylene mesh that integrates well with adhesive systems and acts to constrain internal stresses, helping to prevent crack propagation. Its application has been reported with favorable outcomes in posterior teeth, particularly when combined with adhesive techniques and composite resin [6].

Given the relevance of minimally invasive approaches such as semi-direct restorations, the present work aims to report a clinical case involving the cementation of semi-direct composite restorations in previously endodontically treated maxillary premolars, with and without the use of structural fiber reinforcement.

2. Case Report

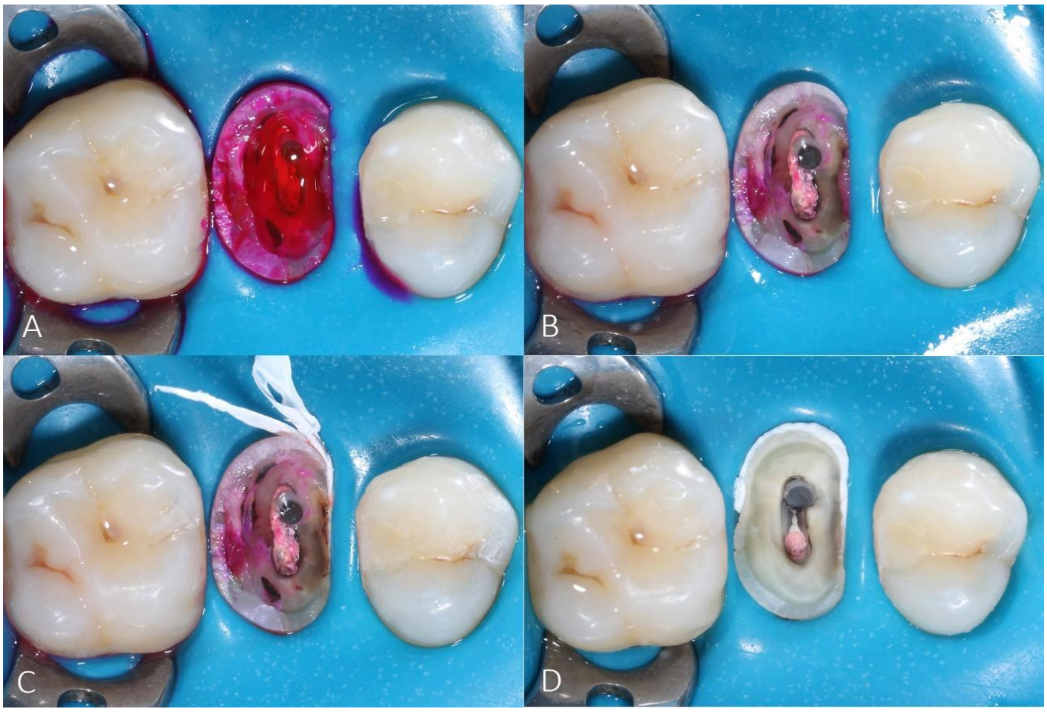
A 32-year-old female patient, presented in October 2023 with the chief complaint of "a fracture in a back tooth." Medical/dental history revealed endodontic treatment of teeth 15 and 24 performed more than three months earlier, without definitive restorations. On clinical examination, tooth 15 showed darkened coloration and a defective restoration with marginal inadaptation, staining, and fracture. Tooth 24 had a provisional restoration (zinc oxide–eugenol) and a distal wall fracture. Radiographically, both root canal treatments appeared satisfactory, and tooth 15 exhibited an exposed glass fiber post within the cavity (Figure 1).

Figure 1: A. Occlusal view of tooth 15. B. Occlusal view of tooth 24. C. Frontal view of tooth 15. D. Frontal view of tooth 24.

The treatment plan consisted of: (1) For tooth 15, retaining the existing glass fiber post, given the risk of root fracture if removed, followed by fabrication of a bi-obase and a semi-direct composite crown, and (2) For tooth 24, a semi-direct composite restoration. The patient provided informed consent. After infiltrative anesthesia (2% lidocaine with 1:100,000 epinephrine) and rubber-dam isolation (teeth 14–16), the defective restoration was removed (diamond bur 1016) and the existing glass fiber post was reduced to the cervical level (Figure 2). Carious tissue was removed using a multi-fluted carbide bur (No. 6) and a caries detector (Evicárie) (Figure 3).

Figure 2: A. Rubber-dam isolation in place. B. Removal of the defective restoration.

Figure 3: Steps of caries removal in tooth 15: (A) Application of caries detector (Evicárie); (B) Removal of stained tissue; (C) Adaptation of PTFE tape to improve marginal sealing; (D) Clean, prepared cavity demonstrating a satisfactory peripheral seal zone.



The cavity was air-abraded with aluminum oxide (10 s). A 5-mm metal matrix was adapted with a Tofflemire retainer to elevate the gingival margin. The adhesive protocol began with selective enamel etching (35% phosphoric acid, 30 s) and application of a self-etch adhesive system (Clearfil SE Bond), followed by light curing (40 s). A resin coating was applied (Grandioso Heavy Flow, <0.5-mm thickness). At the canal orifice, a composite increment (Filtek Z350 XT) was placed together with a polyethylene fiber strip (Ribbond, 3×3 mm) pre-impregnated with adhesive, and the assembly was light-cured (40 s) (Figure 4B). Margins were elevated with composite resin (Figure 4C). After completing the biobase, isolation was removed and the tooth was prepared for a full-coverage crown (bur 2215). An impression (alginate) was made and a stone model (Herostone) was poured. The semi-direct crown was fabricated in composite resin on the model (Figure 4D).

Figure 4: A. Application of the adhesive. B. Polyethylene fiber positioned. C. Preparation for full-coverage crown. D. Fabrication of the semi-direct restoration.

At the subsequent appointment, the restoration was tried in and proximal/occlusal contacts were adjusted (AccuFilm articulating paper). For adhesive luting, under rubber-dam isolation, the substrate (biobase) was prepared by air-abrasion (aluminum oxide, 10 s), phosphoric acid etching (1 min), and adhesive application. The intaglio surface of the restoration was treated with air-abrasion, phosphoric acid etching (1 min), silane application (1 min), and adhesive (Figure 5).

Figure 5: A. Application of the adhesive. B. Polyethylene fiber positioned. C. Preparation for full-coverage crown. D. Fabrication of the semi-direct restoration.

Cementation was performed with flowable resin (Grandioso Heavy Flow) and light-cured for 40 s per surface. After final polishing, the tooth was re-evaluated in April 2025 (1 year 6 months), showing satisfactory adaptation and esthetics (Figure 6). For tooth 24, following anesthesia and rubber-dam isolation (teeth 23–26), the provisional restoration was removed (bur 1016) (Figure 7). Caries removal revealed that the buccal and palatal cusps were each <2 mm thick, confirmed with a thickness gauge. A 2.5-mm reduction was therefore performed on both cusps.

Figure 6: Clinical aspect at 1 year 6 months. A. Frontal view. B. Occlusal view.

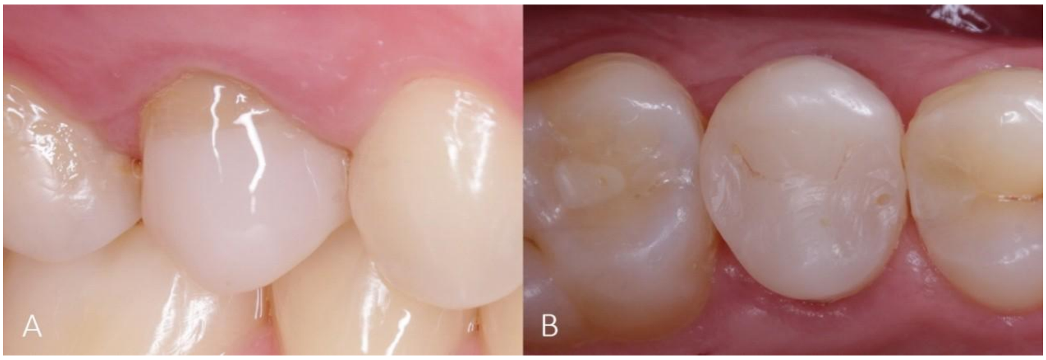
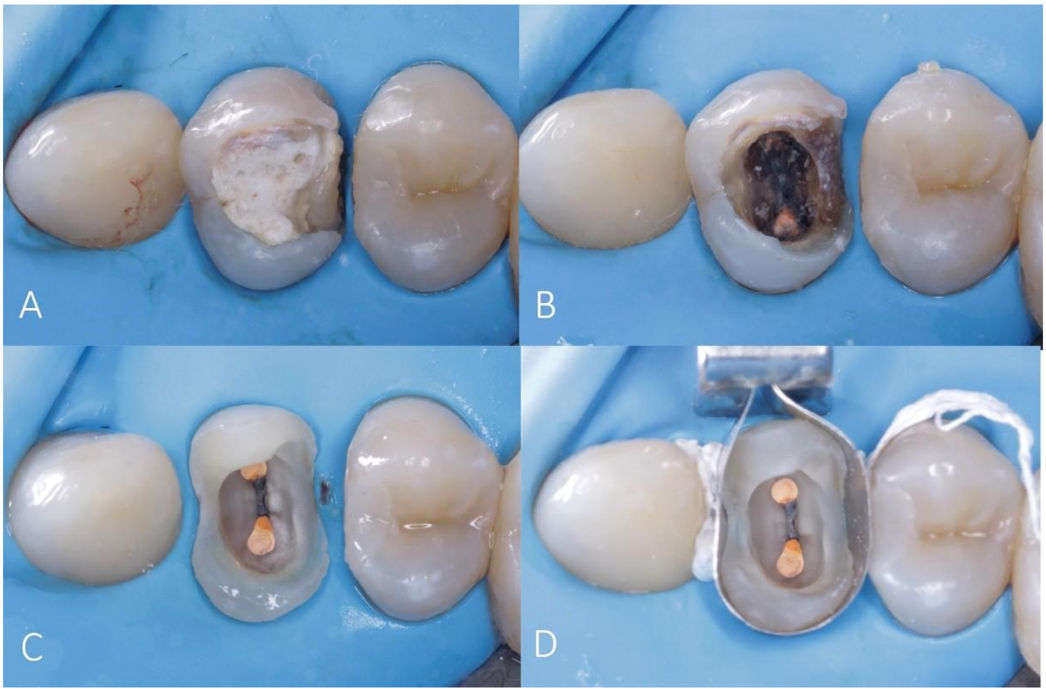


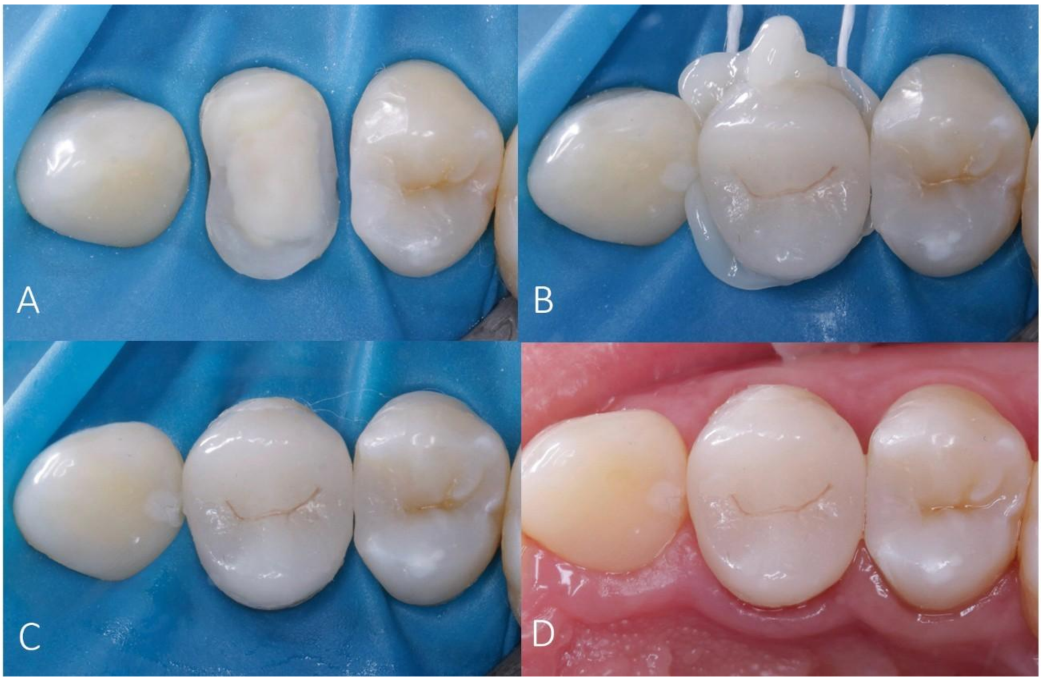
Figure 7: A. Occlusal view under isolation. B. Caries removal. C. Cusp reduction. D. Matrix retainer adapted.



After cleansing and air-abrasion, a Tofflemire matrix was adapted to elevate proximal margins and to build a composite biobase. The adhesive protocol mirrored that of tooth 15, except no polyethylene fiber was used (Figure 8). The biobase was prepared with expulsive walls to receive a semi-direct overlay. An impression (alginate) was made, and the composite overlay was fabricated on a Herostone model. On the following visit, the restoration was tried in and adjusted. The adhesive cementation protocol matched that of tooth 15 for both the substrate and the restoration (air-abrasion, phosphoric acid, silane, and adhesive). Cementation was performed with pre-heated composite resin (Z100) using a warming device (Hotset) (Figure 9). After light curing (40 s per surface) and removal of isolation, occlusal adjustment and final polishing were completed.

Figure 8: A. Application of the self-etch adhesive system. B. Biobase built with composite resin. C. Matrix removal. D. Biobase ready for impression.

Figure 9: A. Application of the self-etch adhesive system. B. Biobase built with composite resin. C. Matrix removal. D. Biobase ready for impression.



4. Discussion

The rehabilitation of endodontically treated teeth with significant structural compromise, such as teeth 15 and 24, is a complex restorative intervention. Selecting minimally invasive techniques and materials with physical and mechanical properties similar to dental tissues, such as composite resin, reflects the pursuit of both functional and esthetic outcomes. Tooth 15 presented with an already cemented glass fiber post, a fractured restoration, and discoloration. Retaining the post was indicated due to its intraradicular extension and the high risk of iatrogenic root fracture associated with attempted post removal. This adaptation of the treatment plan was crucial to preserve structural integrity.

The restorative technique was grounded in the pillars of biomimetic dentistry. In tooth 15, application of the peripheral seal zone concept, the use of a resin coating, and reinforcement with polyethylene fiber (Ribbond) were employed to improve stress distribution and enhance fracture resistance. Polyethylene fiber (Ribbond) undergoes plasma treatment to improve chemical bonding. Although it has traditional indications (e.g., periodontal splinting, fixed partial dentures, post-and-core build-ups), its use has become more frequent in restorative dentistry [7].

In vitro studies suggest that fiber reinforcement acts as a stress-absorbing mechanism, preventing crack propagation. There is also evidence of its effectiveness in reducing polymerization shrinkage stresses and minimizing marginal microleakage. In addition, polyethylene fibers tend to exhibit a safer (non-catastrophic) failure pattern, allowing for repair [8, 9]. Use of a metal matrix adapted with a Tofflemire retainer was essential for the Gingival Margin Elevation technique (GME; also known as Deep Margin Elevation), enabling adequate sealing and control of the operative field. GME, described by Dietschi and Spreafico [10], is advantageous in cavities with subgingival margins because it facilitates adhesive cementation and may obviate periodontal surgical procedures [11].

Fabrication of the crown on a model (semi-direct technique) provided precise control of form, occlusion, and proximal contacts. This approach offers advantages such as reduced polymerization shrinkage, superior polish, and the possibility of extraoral adjustments, all contributing to clinical longevity [12]. A rigorous adhesive cementation protocol was followed, including aluminum-oxide air-abrasion, silane and adhesive application to the restoration, and appropriate preparation of the tooth substrate. Proper chemical and mechanical surface conditioning is fundamental to ensuring effective adhesion [13].

During clinical follow-up (1 year and 6 months for tooth 15), treatment stability was observed, with satisfactory marginal adaptation, absence of staining, and appropriate form/contour. This outcome underscores the effectiveness of an approach that combines preservation of tooth structure with fiber reinforcement. The longevity of endodontically treated teeth is closely related to coronal sealing and management of occlusal forces. Extensive structural compromise increases the risk of catastrophic fractures, highlighting the importance of mimicking natural tissue interfaces [5]. Polyethylene fiber can be a supportive tool, though it is not indispensable. The fabrication of semi-direct restorations under a strict adhesive protocol, as demonstrated in this report, substantiates this point.

5. Conclusion

This clinical case demonstrated that combining adhesive principles with the fabrication of semi-direct composite restorations yields predictable and functional outcomes. Rehabilitation was successful with both approaches: the semi-direct crown with polyethylene fiber reinforcement (tooth 15) and the semi-direct overlay without reinforcement (tooth 24). The decision to maintain the existing glass fiber post (tooth 15), together with a rigorous adhesive protocol for both restorations, enabled conservative and efficient rehabilitation. We conclude that it is feasible to rehabilitate posterior endodontically treated teeth in a minimally invasive manner, respecting the remaining structure and the treatment's longevity, with fiber reinforcement serving as a valuable, though not indispensable, adjunct when a strict adhesive protocol is followed.

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Conflicts of Interest: None.

Supplementary Materials: None.

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