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Case Report

Semi-Direct Posterior Resin Composite Restorations: The Silicone Die Approach

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Abstract

This clinical case report demonstrates a conservative, cost-effective approach to restoring multiple defective posterior composite restorations using the semi-direct technique with a silicone die. A 32-year-old female patient presented with recurrent caries, open contacts, and sensitivity in her upper right quadrant. A semi-direct composite approach was employed after rejecting indirect ceramic options due to financial constraints. The process included Immediate Dentin Sealing (IDS), extraoral fabrication of composite restorations on silicone dies, and thermal post-curing. This approach yielded excellent anatomical form, esthetic integration, and improved patient comfort. The case supports the semi-direct method as a viable alternative to indirect restorations, blending precision, durability, and affordability within a single clinical session.

Keywords: Semi-direct Restoration; Silicone Die Technique; Posterior Resin Composite; Immediate Dentin Sealing; Conservative Dentistry

Introduction

Over the past few decades, the shift toward conservative esthetic dentistry has been driven notably by continuous advancements in adhesive technologies and restorative materials [5,10]. These advancements have expanded the scope of minimally invasive procedures, allowing clinicians to preserve healthy tooth structure while achieving both esthetic and functional rehabilitation [24]. Among restorative materials, resin composites continue to dominate posterior restorations due to their excellent esthetics, improved physical properties, and simplified handling characteristics [4,7].

Selecting the appropriate restorative technique for posterior teeth plays a significant role in determining the clinical success and longevity of the restoration [18]. This clinical decision is shaped by multiple factors, including the location and extent of the lesion, the number of teeth involved, esthetic and functional demands, periodontal status, and the clinician's expertise and judgment [22]. Broadly, three approaches are available: direct, indirect, and semi-direct restorations.

Direct resin composites have gained widespread acceptance in restorative dentistry due to their ability to replicate natural tooth structure's optical and mechanical properties, offering a broad selection of shades and translucencies along with favorable flexural strength, tensile resistance, and fracture toughness [4,7]. While this technique is cost-effective and can be completed in a single visit, its limitations become evident in large or complex cavities where achieving ideal anatomic contour, tight proximal contacts, and adequate polymerization is challenging [23]. In contrast, indirect restorations are fabricated externally, either in a dental laboratory or chairside using Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) technology, then cemented or adhesively bonded to the tooth [6]. These restorations provide superior control over morphology, contact areas, and mechanical strength but often require multiple appointments, temporary restorations, and higher costs [8,16,21].

The semi-direct technique, first introduced in the 1980s, was developed to bridge the gap between direct and indirect approaches by offering the advantages of both while minimizing their respective drawbacks [2,9,13,19]. This technique involves fabricating the restoration either intraorally or extraorally during the same clinical session, often using a flexible silicone die to externally model the restoration [1,11]. Among the two variants, the extraoral approach is preferred due to its greater control over anatomy and esthetics, as well as its compatibility with more conservative preparation designs that require less cavity divergence [11].

In this method, the resin composite is incrementally layered and sculpted on the die to mimic natural occlusal anatomy, then light cured outside the mouth. This extraoral polymerization improves monomer conversion and mechanical properties, such as microhardness and wear resistance, while reducing polymerization shrinkage and marginal stress [1,11]. The final restoration is then adhesively luted in place, completing the entire procedure within a single visit.

The semi-direct approach presents several clinical advantages, notably enhanced control over anatomical form, improved marginal adaptation, more predictable proximal contact establishment, and greater efficiency by minimizing chairside time [1,2]. This technique does not require a laboratory and temporization phase, making it a cost-effective and alternative option to indirect restorations without affecting clinical efficiency [11,19]. Additionally, this technique improves the durability of adhesive bonds and lowers the risk of marginal leakage and secondary caries because polymerization stresses are confined to the thin luting layer [1,11].

However, limitations include sensitivity to cavity configuration, particularly in cases with undercuts or minimal taper, and the need for precise manual skills during extraoral contouring [1]. Furthermore, while laboratory involvement is unnecessary, the technique does require additional materials, such as dual-viscosity silicone impression systems and a light-curing oven for post-polymerization [11].

Case Report

A 32-year-old female patient, with no significant medical history, presented with the chief complaint: “My upper right fillings are sensitive, and food gets stuck in between”. Radiographic and clinical examination revealed defective resin composite restorations in the upper right first premolar, second premolar, and first molar. The restorations exhibited open contacts and recurrent caries (Figure 1).

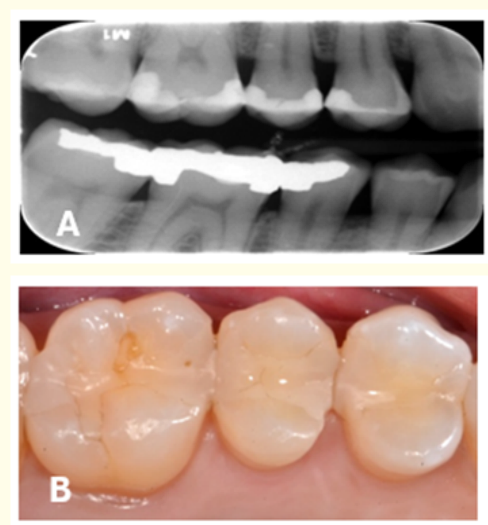

Figure 1: Radiographic and clinical views of the defective restorations. (A) Preoperative bitewing radiograph. (B) Clinical image showing occlusal view of the failing restorations.

The patient expressed concern regarding cost, which precluded using indirect ceramic or composite inlays. After a thorough discussion of treatment options, the semi-direct composite restoration using a silicone die technique was proposed. The patient consented to proceed with this approach.

Before starting the treatment, the shade was selected using the Vit-l-escence™ shade guide, and A1 and Pearl Frost (PF) were chosen (Figure 2).

Figure 2: Shade selection using the Vit-l-escence™ shade guide.

The patient was anesthetized, and a rubber dam was applied (Figure 3).

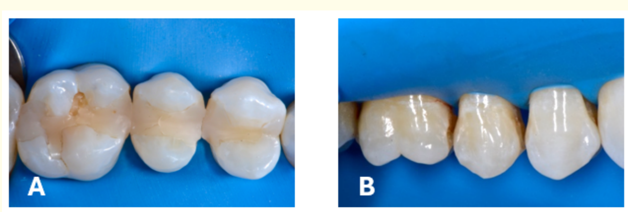

Figure 3: Rubber dam isolation. (A) Occlusal view. (B) Buccal view.

Existing resin composite restorations were removed, and the cavity preparation was strictly limited to removing old composite and decayed tooth structure (Figure 4).

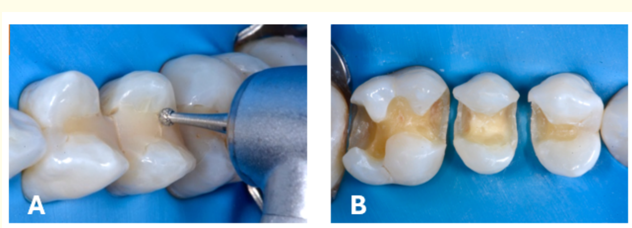

Figure 4: Removal of existing restorations and cavity preparation. (A) Use of a round diamond bur to remove defective restorations. (B) Completed cavity preparations.

Immediate dentin sealing (IDS) was performed using 37% phosphoric acid gel and OptiBond™ FL adhesive system. Subsequently, the light curing process was completed (Figure 5).

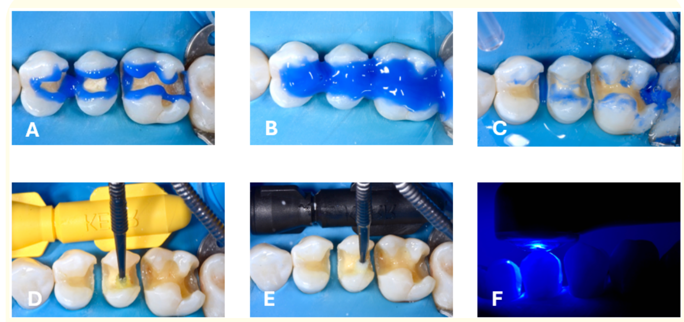

Figure 5: Immediate dentin sealing (IDS) procedure. (A) Selective enamel etching for 15 seconds with 37% phosphoric acid gel. (B) Total-etch of enamel and dentin for 15 seconds. (C) Rinsing and gentle drying. (D) Application of OptiBond™ FL primer. (E) Application of OptiBond™ FL adhesive. (F) Light curing of the adhesive layer.

Impressions for both arches were taken using alginate with sectional trays, and Mach-2® Die-Silicone was used to fabricate working models, which were mounted according to the patient's bite registration before separating the dies with a surgical blade (Figure 6).

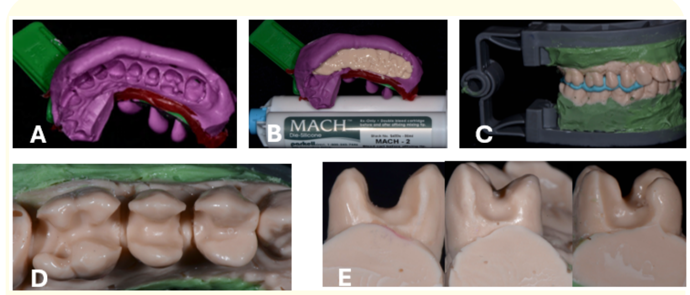

Figure 6: Fabrication, mounting, and die separation of working models. (A) Alginate impression. (B) Application of Mach-2® Die-Silicone. (C) Mounted working models using bite registration. (D) Occlusal view of the silicone working model. (E) Sectioned dies for restoration fabrication.

The restorations were completed using an incremental layering technique with Vit-l-escence™, starting with dentin shade A1, followed by the placement and careful sculpting of Pearl Frost (PF) to refine the occlusal anatomy and establish proper proximal contacts. Once the desired form and contours were achieved, the restorations were thoroughly light-cured (Figure 7).

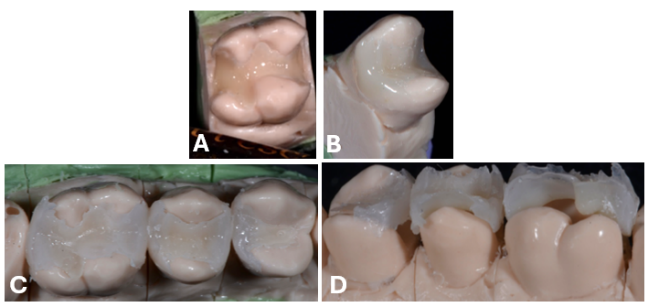

Figure 7: Fabrication of resin composite restorations using Vit-l-escence™. (A) Occlusal view during application of the resin composite. (B) Proximal view during application of the resin composite. (C) Occlusal view of the completed, light-cured restorations. (D) Buccal view of the finalized restorations after light curing.

Initial finishing of the restorations was performed using Sof-Lex™ discs and Enhance® finishing cups (Figure 8).

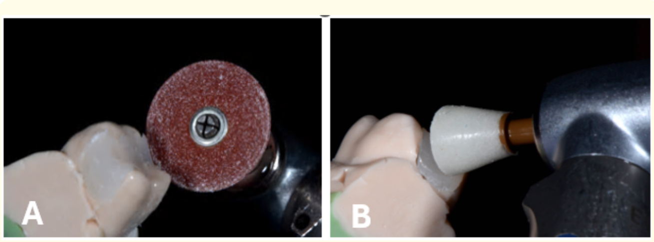

Figure 8: Initial finishing of the restorations. (A) Finishing with Sof-Lex™ discs. (B) Finishing with Enhance® cups.

To achieve maximum monomer conversion of the resin composites, dimensional stability, and improved mechanical properties, the restorations were subjected to heat treatment using an autoclave for 7 minutes at 120 °C. Subsequently, final finishing and polishing of the restorations were performed using Sof-Lex™ discs, Enhance® finishing cups, and a Jiffy™ polishing brush (Figure 9).

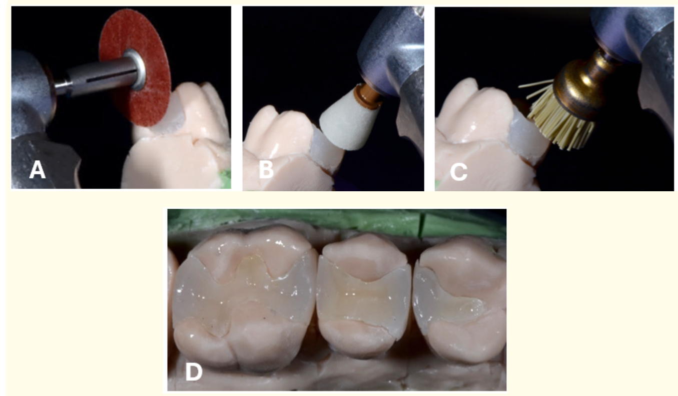

Figure 9: Final finishing and polishing of the restorations. (A) Finishing with Sof-Lex™ discs. (B) Finishing with Enhance® cups. (C) Polishing with Jiffy™ brush. (D) Occlusal view of the polished restorations.

The internal surface of the restorations was cleaned with soft air abrasion using 30 microns (μm) aluminum oxide (Al_2O_3) particles to remove try-in contaminants and enhance bonding, etched with 37% phosphoric acid gel, and followed by the application of a thin, uncured adhesive layer (Figure 10).

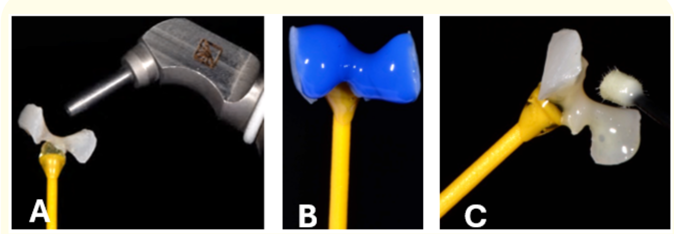

Figure 10: Restoration surface treatment prior to cementation. (A) Air abrasion for 10 seconds. (B) Etching with 37% phosphoric acid gel for 30 seconds. (C) Application of OptiBond™ FL adhesive.

The prepared cavities were cleaned with soft air abrasion, etched with 37% phosphoric acid gel, rinsed, dried, and coated with OptiBond™ FL without light curing (Figure 11).

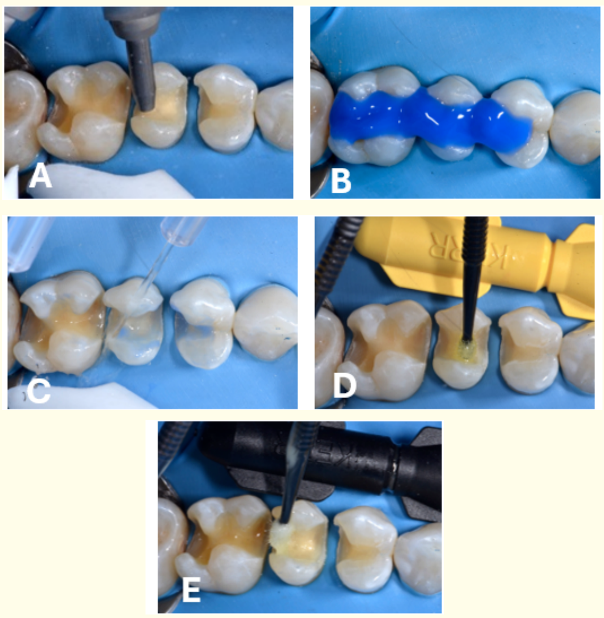

Figure 11: Tooth surface treatment prior to cementation. (A) Air abrasion for 10 seconds. (B) Total-etch of enamel for 30 seconds and dentin for 15 seconds using 37% phosphoric acid gel. (C) Rinsing and gentle drying. (D) Application of OptiBond™ FL primer. (E) Application of OptiBond™ FL adhesive.

An adequate amount of A1 3M™ Filtek™ Supreme flowable composite was applied to the cavity surface to facilitate cementation; the restorations were then carefully seated, stabilized using a blunt instrument, light-cured, and excess flowable composite was removed (Figure 12).

Following cementation, occlusion and proximal contacts were carefully evaluated and adjusted as necessary to ensure functional occlusion, optimal interproximal hygiene, and patient comfort (Figure 13).

Final radiographic and clinical assessments and post-treatment images confirmed the successful replacement of the defective restorations with anatomically accurate, esthetically harmonious, and structurally reinforced semi-direct resin composite restorations. These restorations demonstrated their refined integration with surrounding tissues and notable improvements in occlusal function, contour, and proximal contacts (Figure 14).

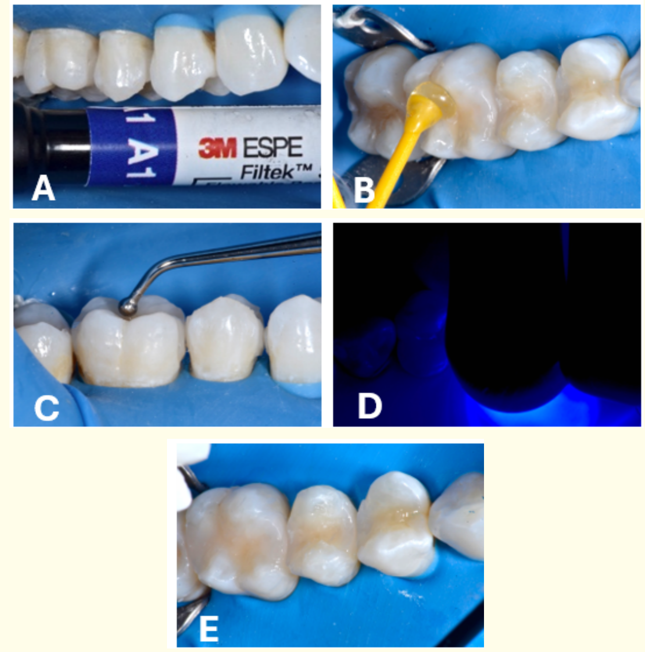

Figure 12: Cementation of semi-direct restorations. (A) A1 3M™ Filtek™ Supreme flowable composite used as the luting material. (B) Seating of the restoration. (C) Stabilization of the restoration with a blunt instrument. (D) Light curing. (E) Occlusal view of the cemented semi-direct restorations.

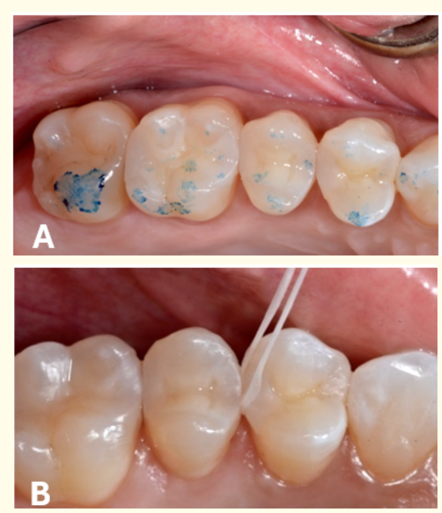

Figure 13: Evaluation of occlusion and proximal contacts. (A) Occlusion checked using articulating paper. (B) Proximal contact verified using dental floss.

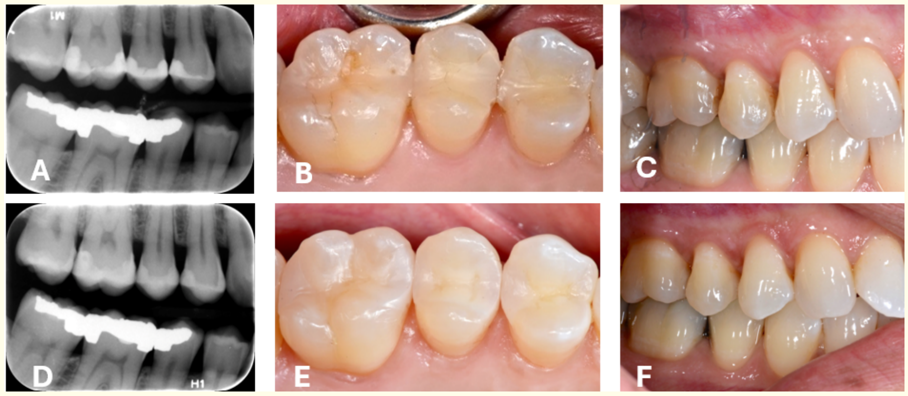

Figure 14: Comparison before and after treatment. (A) Preoperative bitewing radiograph. (B) Preoperative occlusal view. (C) Preoperative buccal view. (D) Postoperative bitewing radiograph. (E) Postoperative occlusal view. (F) Postoperative buccal view.

Discussion

Secondary caries is one of the primary reasons for failure and subsequent replacement of posterior composite restorations [20]. It is often attributed to polymerization shrinkage-induced stress and subsequent degradation at the adhesive interface, which compromises marginal integrity and facilitates bacterial infiltration [3]. The semi-direct composite technique addresses many of these challenges by relocating polymerization outside the oral cavity, thereby limiting the internal stresses exerted on the bonded margins and reducing the risk of marginal gap formation [1,11].

Compared to direct restorations, the semi-direct method significantly improves the clinician's ability to sculpt precise anatomic occlusal morphology and establish proper interproximal contacts [1]. This is achieved without reliance on matrix systems or complex isolation techniques, offering superior esthetic and functional outcomes, particularly in extensive Class II restorations [11]. Furthermore, this technique minimizes chairside time by avoiding laboratory intervention and delivering a cost-effective and efficient treatment alternative that preserves healthy tooth structure while meeting patient expectations [1,11].

In this case, the incorporation of Immediate Dentin Sealing (IDS) played a fundamental role. IDS involves sealing the freshly prepared dentin surface immediately after cavity preparation with an adhesive resin. This step maintains the vitality and integrity of the dentin, enhances the quality of the hybrid layer, improves the bond strength, and significantly reduces the likelihood of postoperative sensitivity and marginal leakage [15].

Following fabrication, the restorations underwent heat treatment at 120 °C for 7 minutes [27]. Studies show that the thermal post-curing technique enhances the composite's degree of monomer conversion, resulting in improved mechanical properties, including higher hardness, increased wear resistance, and greater dimensional stability [17,26].

Air abrasion was employed to prepare the internal surfaces of the restorations before cementation. This step effectively removed surface contaminants from the try-in procedure and provided micromechanical retention by increasing surface roughness. Air abrasion has been shown to support adhesive bonding by enhancing the surface energy and wettability of composite surfaces, particularly when aluminum oxide particles are used [14].

In terms of cementation, a flowable resin composite was chosen as the luting agent. The use of A1 shade 3M™ Filtek™ Supreme flowable composite facilitated easy application and adaptation to the cavity walls. Recent research supports the effectiveness of flowable resin composites as viable alternatives to conventional resin cements, offering higher filler content than many resin cements while maintaining optimal viscosity, which leads to improved handling, reduced voids, and high bond strength [12].

This case report highlights how the semi-direct technique can be a practical and efficient restorative option without compromising quality when applied carefully. Its success relies on integrating adhesive protocols and material science with respect to biological principles. The procedure provides a balanced treatment option, combining clinical precision with esthetic and functional benefits, while minimizing chairside time and the number of appointments. Moreover, while comprehensive long-term studies are still limited, clinical evaluations and technique reviews have reported favorable outcomes in terms of marginal adaptation, esthetics, and restoration longevity when semi-direct protocols are properly followed [1,11,25]. To illustrate, in an 11-year clinical evaluation, Van Dijken (2000) observed that semi-direct resin composite inlays and onlays demonstrated favorable long-term performance. The restorations exhibited stable marginal adaptation over time and were associated with a notably low incidence of secondary caries, underscoring their potential as a durable and biologically restorative option [25]. As adhesive materials and polymerization technologies continue to evolve, the clinical applications of the semi-direct technique are likely to expand, reinforcing its value in contemporary restorative dentistry.

Conclusion

The semi-direct approach using a silicone die offers a clinically practical and efficient alternative for restoring posterior teeth, particularly in cases when time and cost are significant concerns. It incorporates the advantages of direct and indirect restorations while minimizing their drawbacks without compromising the quality of clinical outcomes.

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Conflict of Interest

The author declares no conflicts of interest.

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