# Comprehensive Management of Extensive Root Defect in Maxillary Molar Using Pre-Endodontic Build-Up and Adhesive Onlay: A Case Report

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## ABSTRACT

**Background**: Managing teeth with extensive root defects from secondary caries in failed restorations poses a significant clinical challenge, especially when restoration margins approach or extend beyond the gingival margin. **Objective**: To describe comprehensive endodontic and restorative management of a maxillary second molar with a severe root defect. **Case Report**: A 55-year-old woman presented with thermal sensitivity and a history of spontaneous radiating pain in the upper left posterior region. Clinical examination revealed a defective composite restoration with ICDAS 3, 2 root caries on tooth #17. Radiographs confirmed pulp involvement associated with an extensive defect on the distal surface of the root. The diagnosis was asymptomatic irreversible pulpitis with normal apical tissues. After local anesthesia and complete caries removal, a pre-endodontic build-up was performed using a sectional matrix system (Palodent® V3, Dentsply Sirona, USA) to reconstruct coronal walls and minimize contamination risk during root canal therapy. Biomechanical preparation was done with reciprocating NiTi instruments (Reciproc Blue®, VDW, Germany) followed by single-cone obturation with a bioceramic sealer. The final restoration was digitally designed using an intraoral scanner and CAD software. An indirect lithium disilicate adhesive onlay was selected to restore occlusal function. At follow-up, the tooth showed no symptomp and functionally stable. **Conclusion**: The integration of pre-endodontic build-up with indirect adhesive restoration offers a conservative and effective approach for managing posterior teeth with extensive root defects, preserving structural integrity and ensuring long-term clinical success.

**Keywords**
Adhesive onlay, endodontic treatment, pre-endodontic build-up, reciprocating NiTi instrument, root defect.

## INTRODUCTION

Conservation and rehabilitation of endodontically treated teeth (ETT) with extensive coronal or root destruction of maxillary molars have been a long-standing challenge in restorative dentistry. Conventional methods like the use of full-coverage crowns and posts traditionally have required excessive tooth structure removal and, as a result, undermined the biomechanical resistance and prognosis. During the last few decades, substantial improvements in adhesive dentistry, computer-aided design procedures, and high-strength restorative materials—lithium disilicate ceramics most of all—have led clinicians to accomplish increasingly more conservative, biomimetic restorative methods that support the remaining tooth structure, reduce invasiveness, and maximize longevity and function. Large root defects in posterior maxillary teeth are often caused by extensive carious lesions, restoration failure, trauma, or coincident structural loss and endodontic infection. The International Caries Detection and Assessment System (ICDAS), which is now widely applied in clinical as well as research contexts, offers a standardized evidence-based system for scoring severity as well as activity of caries—essential to directing individualized tissue-conserving treatments.[1]

A pivotal evolution in the restorative management of such cases is the use of pre-endodontic build-up with sectional matrix systems, enabling predictable deep margin elevation, optimal isolation, and the re-establishment of lost coronal walls, thereby facilitating subsequent endodontic and restorative procedures. Modern nickel-titanium reciprocating file systems allow for efficient, safe, and anatomically respectful root canal preparation, while contemporary bioceramic sealers support a streamlined, single-cone obturation method that delivers excellent apical sealing and biocompatibility.[2,3]

Partial coverage approaches such as onlay made from lithium disilicate have shown similar or higher clinical performance and patient satisfaction compared to traditional full crowns, especially when utilized with fiber-reinforced composite posts or robust pre-endodontic build-ups. The clinical benefit is further enhanced by the superior marginal adaptation and minimal invasiveness of pressed onlay, which protect the remaining tooth structure, support functional loading, and provide strong coronal seals, all of which are essential in teeth compromised by extensive restoration or caries.[4]

This case report, structured according to the CARE guidelines, details the comprehensive, multidisciplinary management of extensive root and coronal defect in a maxillary second molar, highlighting a sequence of modern diagnostic and therapeutic strategies, culminating in the restoration of function and esthetics with a digitally designed lithium disilicate adhesive onlay.

## CASE REPORT

A 55-year-old woman was referred to the dental clinic with the chief complaint of acute thermal sensitivity and increasingly frequent episodes of spontaneous pain in the upper left posterior maxilla. The patient's dental history included a composite restoration of the maxillary right second molar (tooth #17), completed approximately 5 years prior. She denied any systemic conditions, recent orofacial trauma, or allergies. Her family medical and dental history was non-contributory. Clinical examination revealed a defective composite restoration involving the disto-occlusal surfaces of tooth #17. Thermal (cold) testing elicited an exaggerated, lingering response in the affected tooth, with pain persisting for over 30 seconds following stimulus removal. Electric pulp testing stimulate heightened responsiveness compared to adjacent teeth. No discomfort was elicited upon percussion, and there was no evidence of apical swelling or mucosal changes.

**Table 1.** The sequence of diagnostic, therapeutic, and follow-up interventions, emphasizing both the structured approach and patient adherence throughout the case.

| **Date** | **Intervention/Event** |
|---|---|
| 2024 – 12 – 20 | Clinical and radiograph examination; definitive diagnosis, treatment planning, informed consent; caries removal; pre-endodontic build-up; root canal treatment: biomechanical preparation; intracanal medicament. |
| 2025 – 01 – 03 | Obturation, core build up |
| 2025 – 01 – 08 | Onlay preparation, digital impression |
| 2025 – 01 – 15 | Adhesive placement of lithium disilicate onlay |
| 2025 – 02 – 18 | 4 weeks clinical and radiographic follow-up |
| 2025 – 05 – 20 | 3 months clinical and radiographic follow-up |

Upon clinical examination, the restoration margins were degraded, with visible secondary caries extended into the root dentin. Using the ICDAS protocol, the lesion was characterized as ICDAS code 3, 2 root caries: a loss of anatomical contour on the root surface >= 0,5 mm, associated with a defective resin composite restoration. There was no tooth mobility, swelling, or sinus tract formation. Periodontal probing revealed normal gingival sulcus with no periodontal disease. Periapical radiograph assessment, demonstrated a radiolucent area beneath the restoration, extending into the root dentin and the pulp chamber—indicative of pulpal involvement. The root canal was not clearly visible on radiograph indicating calcified or narrow canals. The periapical region appeared normal, with well-circumscribed lamina dura and an intact periodontal ligament space. The defective restoration, coupled with microleakage, was the major predisposing factor.[5]

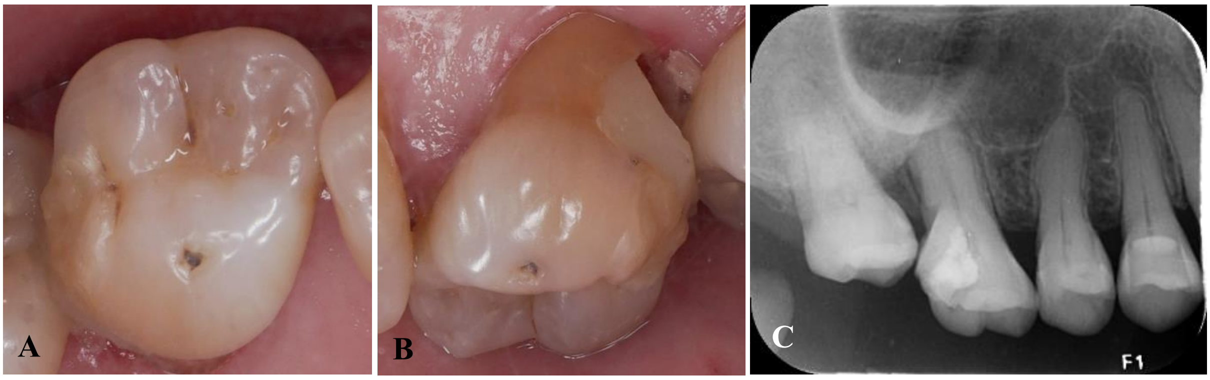


**Figure 1.** Preoperative tooth #17 (A) revealed secondary caries extended into the root dentin (B). Preoperative radiograph demonstrated a radiolucent area beneath the restoration, extending into the root dentin and the pulp chamber (C).

Following the American Association of Endodontists (AAE) diagnostic criteria, the tooth was diagnosed as asymptomatic irreversible pulpitis with normal apical tissues. This was based on positive clinical signs (exaggerated, lingering thermal sensitivity; spontaneous but non-localized pain), a vital but irreversibly inflamed pulp, and lack of periapical involvement. Further, the clinical findings ruled out symptomatic irreversible pulpitis (no spontaneous severe pain), necrosis (positive response to vitality testing), and excluded acute or chronic apical periodontitis (normal percussion, no apical radiolucency).[6]

Despite significant structural compromise, preservation of a circumferential ferrule of at least 2 mm with healthy periodontal support provided a favorable prognosis for adhesive restoration. The defect did not extend subcrestally, and adjacent tooth structure was sound, indicating that an adhesive indirect restoration was feasible. No diagnostic or access challenges impeded clinical management; CBCT was not deemed necessary due to the clarity of standard periapical views and clinical access.

Informed patient consent was obtained before the procedure. Profound anesthesia was achieved via supraperiosteal infiltration injection using 1.8 mL 2% lidocaine with 1:100,000 epinephrine. Supplemental infiltration was given in the palatal region for hemostasis and comfort. Rubber dam isolation was meticulously applied using a winged clamp designed for extensive posterior defects, ensuring a dry field and optimizing infection control—a clinical standard strongly reinforced in endodontics and restorative practice.[7,8]

Following rubber dam application, all defective restorative material and carious tissue were meticulously removed with round carbide burs under high magnification and illumination. The lesion extended subgingivally on the distal aspect, exposing the root surface and precluding effective wall retention. Deep margin elevation was performed using a sectional matrix system (Palodent® V3, Dentsply Sirona, USA). This system, with its anatomically contoured matrices, NiTi separation ring, and polymer wedges, allowed for optimal adaptation to deep, irregular margins, recreation of proximal contact, and protection of periodontal tissues. A universal adhesive system (Single Bond™ Universal, 3M ESPE, USA) was applied to the freshly prepared dentin/enamel, followed by incremental placement of composite resin (Clearfil™ AP-X, Kuraray Noritake Dental, Japan) to reconstruct lost proximal walls.[9]

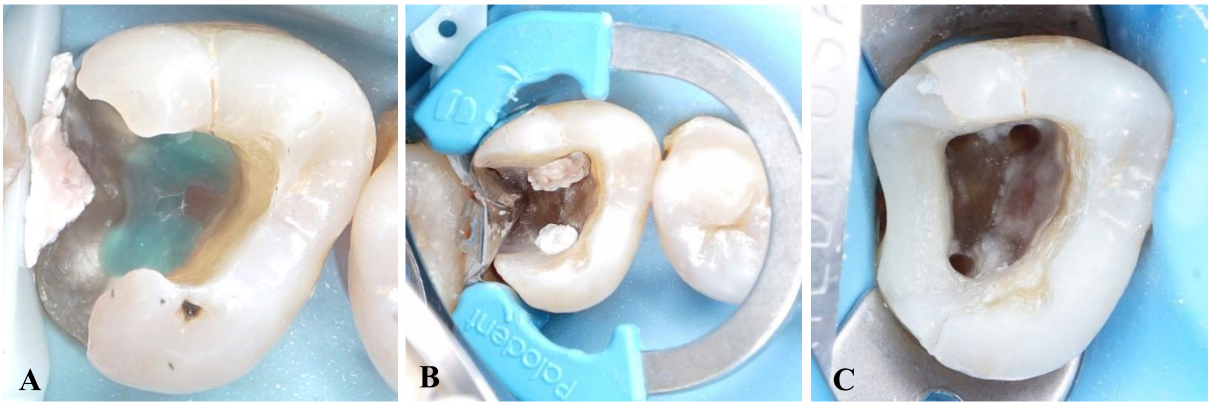


**Figure 2.** Total Caries Removal (A). Placement of palodent® V3 sectional matrix system (B). Pre-edndodontic build up to reconstruct lost proximal walls (C).

An endodontic access cavity was refined through the newly built-up restoration. All pulp chamber contents were debrided under copious irrigation with 3% sodium hypochlorite, achieving complete removal of necrotic/inflamed tissue. Working length was established with a #10 K-file in conjunction with an apex locator integrated endomotor (E-Connect S™, Eighteeth Medical, China). Biomechanical root canal preparation was undertaken with reciprocating NiTi instruments (Reciproc Blue®, VDW, Germany). This single-file, reciprocating NiTi system combines thermo-mechanical treatment (enhanced flexibility and fatigue resistance) with efficient cutting and debris removal—particularly well-suited to complex and challenging root anatomy. The R25 Reciproc Blue file was employed for the primary shaping of the principal root canals using a gentle in-and-out pecking motion after patency confirmation. The system's regressive taper and S-shaped cross-section provided effective shaping while minimizing transportation and maintaining the natural anatomy. Irrigation was performed after each pass with 3 mL 3% NaOCl, and a final rinse with 5 mL 17% EDTA to remove the smear layer, followed by distilled water and thorough canal drying. The use of Reciproc Blue allowed rapid, safe preparation with minimized risk of instrument fracture—even in calcified or narrow canals. The single-file approach streamlined the protocol and reduced potential for cross-contamination. Calcium hydroxide paste was used as intracanal medicament.[10]

Obturation was completed at the next appointment using the single-cone technique with matched taper gutta-percha and a calcium silicate-based bioceramic sealer (Ceraseal™, Meta Biomed, Korea). The sealer was introduced into the canal using a direct syringe, then the master cone was seated to working length, creating a hydraulic seal. Contemporary evidence supports that single-cone obturation with bioceramic sealer provides sealing efficacy and biocompatibility comparable to multi-cone or warm vertical compaction methods, especially in well-shaped, anatomically round canals typical of maxillary molars. The advantages include simplified clinical workflow, lower risk of extrusion, and excellent intratubular penetration—even in the apical region. The tooth surface was treated with total etch (Any-Etch®, Mediclus, South Korea) for 20 second, rinsed, followed by application of universal adhesive system (Single Bond™ Universal, 3M ESPE, USA), air-thinned and light cured for 20 second. A light-cured flowable resin composite (SDR® Flow+, Dentsply Sirona, USA) was placed to intracoronal barrier and fiber-reinforced composite (everX Posterior™, GC Corporation, Japan) was placed with incremental layering technique.[11]

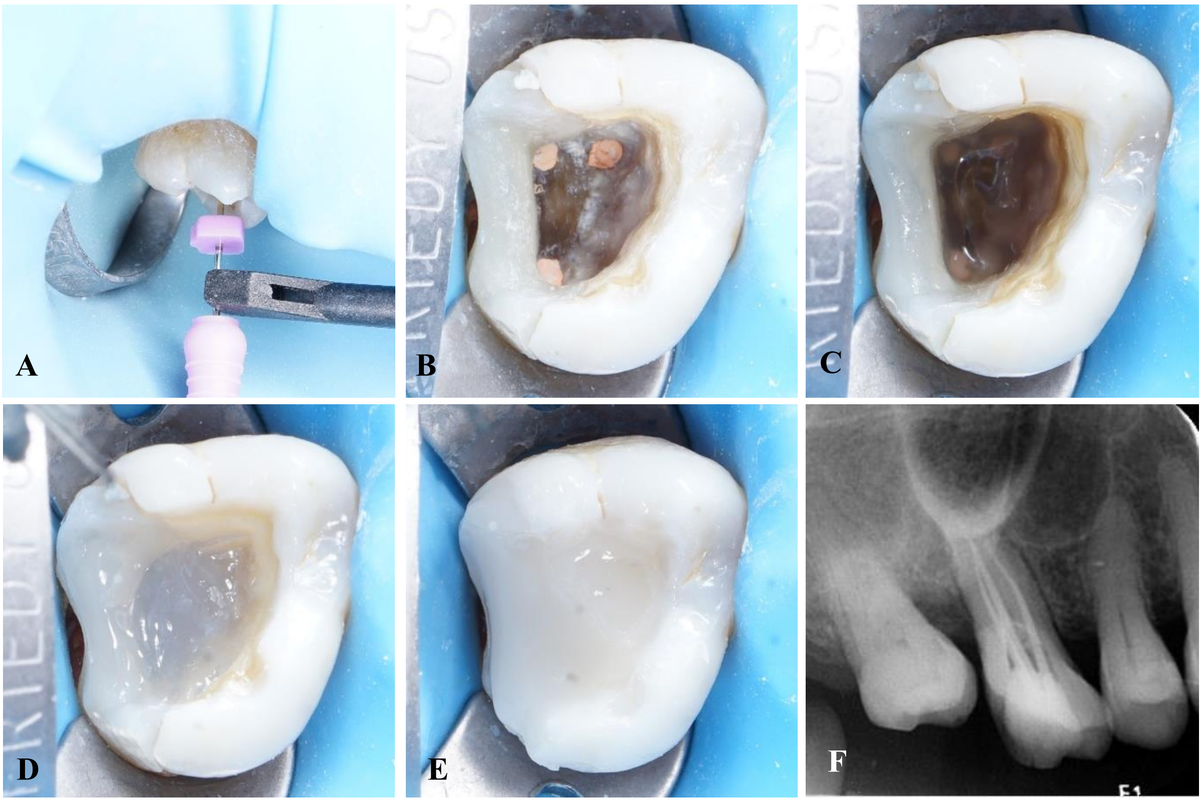


**Figure 3.** Working length determination with a #10 K-file (A). Single cone obturation with bioceramic sealer after biomechanical preparation (B). Intra-orifice barrier after application of universal bonding system (C). Core build-up with fiber reinforced composite (D). Final layer of packable composite (E). Periapical radiograph of obturation (D).

Onlay preparation was done on the next visit and final digital intraoral impression was taken using a digital intraoral scanner (Primescan™, Dentsply Sirona, USA). Temporary onlay was fabricated using light cured temporary crown material (Ezi-Crown®, Mediclus, South Korea). A lithium disilicate (IPS e.max Press™, Ivoclar Vivadent, Liechtenstein) onlay was digitally designed to cover lost cusps, re-establish proximal and occlusal contacts, and provide full coverage of the extensive palatal and distal defects. The design followed the contemporary criterion of cusp capping when remaining wall thickness was < 2mm, and aimed to maximize enamel preservation on buccal and mesial aspects.[12]

On the next appointment, a lithium disilicate onlay was prepared for cementation. The intaglio surface of the onlay was prepared by 20-second etching with hydrofluoric acid gel (Porcelain Etch™, Ultradent, USA), rinsed, dried, and silanized (Silane™, Ultradent, USA) to promote chemical bonding. The tooth surface was treated with air abrasion using 30 – micron aluminum oxide powder for 20 seconds. The prepared tooth received selective enamel etching with 37% phosphoric acid (Any-Etch®, Mediclus, South Korea); a universal adhesive (Single Bond™ Universal, 3M ESPE, USA) was then applied, air-thinned and light cured for 20 second. The onlay was bonded using pre-heated composite (Clearfil™ AP-X, Kuraray Noritake Dental, Japan), carefully seated and gentle pressure to avoid voids. Excess composite was removed prior to final light curing for 20 second each side. Rubber dam isolation was strictly maintained throughout the procedure.[13]

Marginal adaptation was verified visually and with explorer; occlusion was checked in maximum intercuspation and excursive movements. Minimal finishing and polishing were required due to the precision fit afforded by digital impression and design.

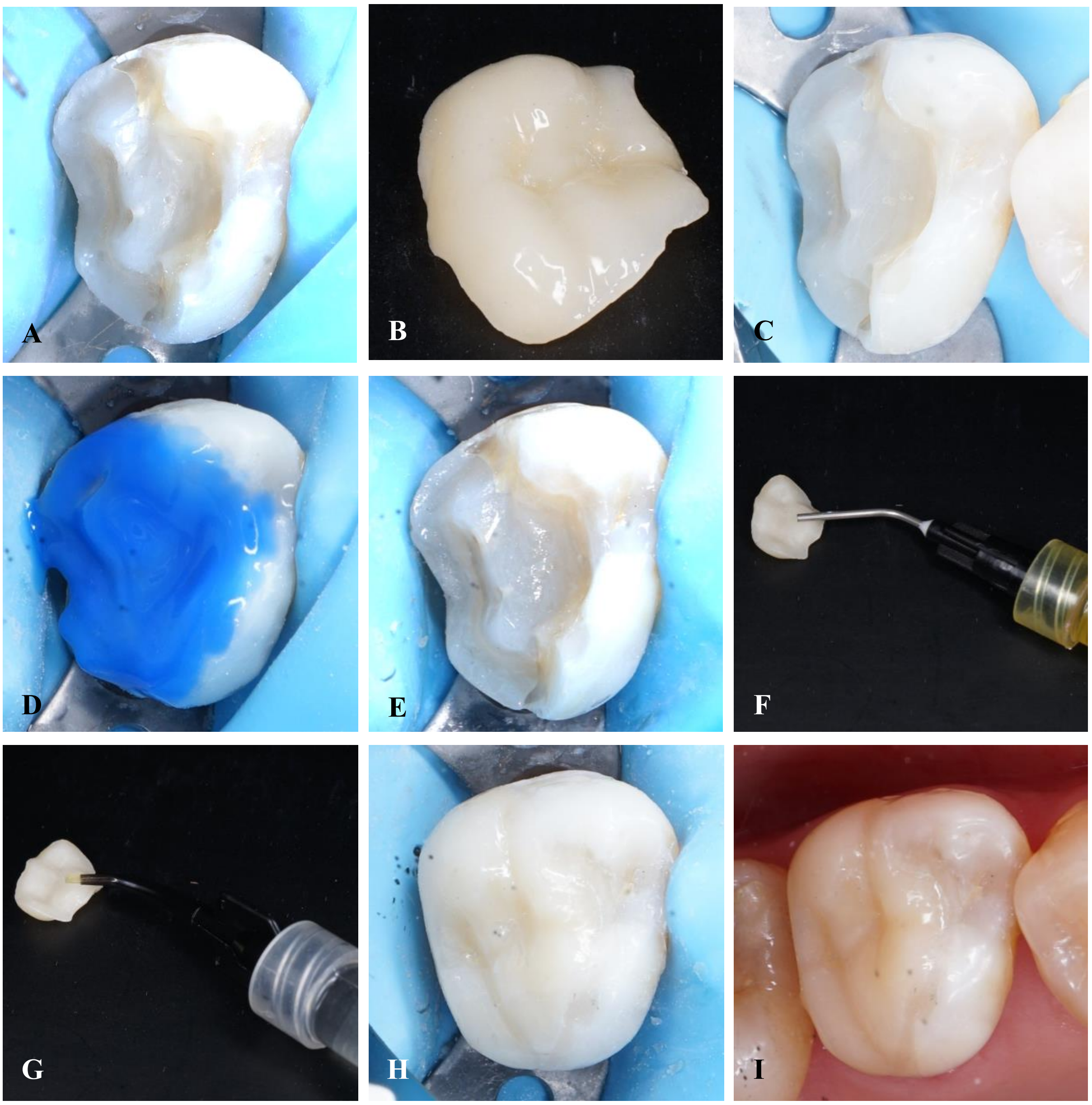


**Figure 4.** Onlay preparation (A). Lithium Disilicate onlay (B). Tooth surface treatment with air particle abrasion (C), total etch (D) and silane-containing universal adhesive (E). Intaglio surface treatment with hydrofluoric acid (F) and silane (G). Onlay cementation with pre-heated composite (H). Post – operative tooth #17 (G).

At four weeks follow-up, the patient reported no symptoms, thermal sensitivity, or difficulty in mastication. There were no signs of symptom, marginal leakage or fracture. Clinical and radiographic assessment confirmed a healthy periodontal and periapical tissues and the functional stability of the tooth.

A recall at three months documented preservation of periodontal health, unchanged periapical radiograph, and an intact, stable onlay without debonding, chipping, or marginal discoloration. The patient expressed high satisfaction with the esthetic outcome and comfort—a result harmonizing with published survival rates and success rates for similar adhesive restorative approaches in posterior endodontically treated teeth. No adverse events, complications, or restoration failures were reported. The outcome validated the clinical sequence and material choices.

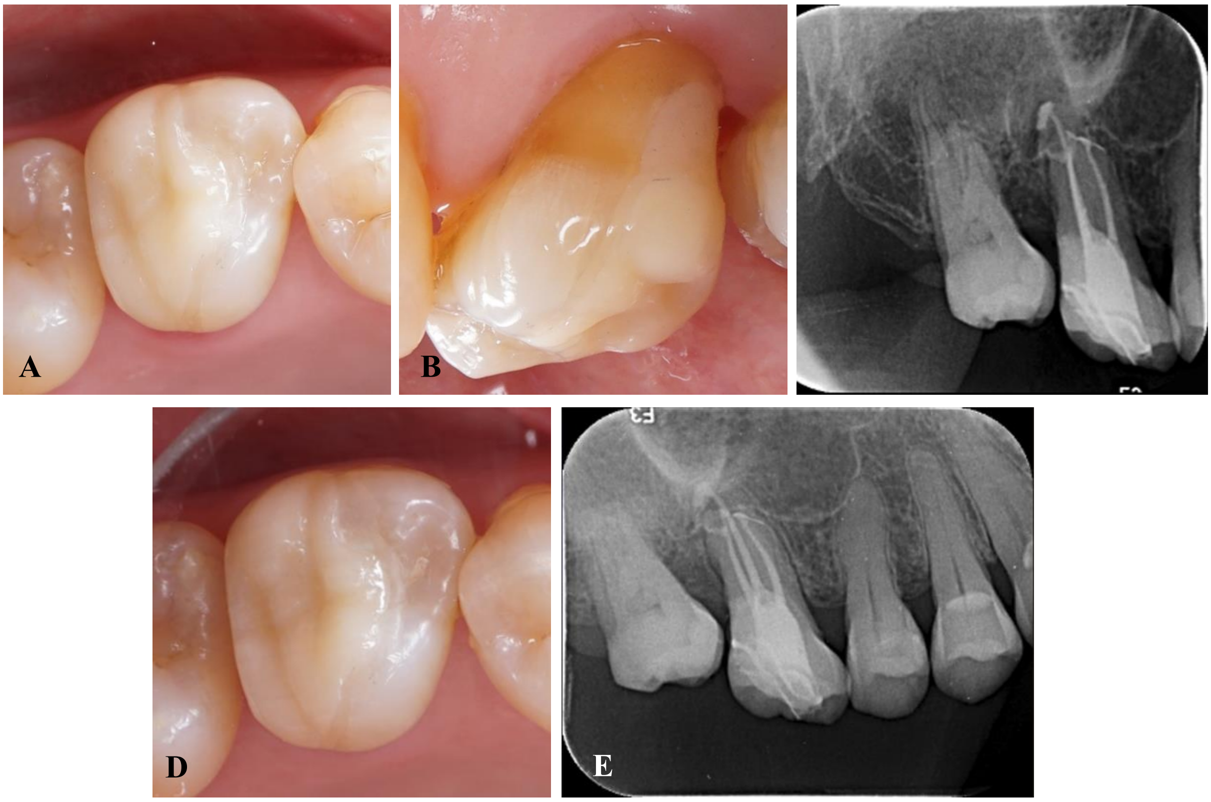


**Figure 5.** Four weeks follow up photograph from occlusal surface (A) and palatal surface (B). Periapical radiograph at four weeks follow-up (C). Three months follow up photograph from occlusal surface (D). Periapical radiograph at three months follow-up (E).

## DISCUSSION

The rehabilitation of teeth with extensive coronal and root carious lesions, particularly in maxillary molars, requires an integrated concept with caries risk assessment, biological conservation, and biomechanical support. In this situation, caries below the gum line would have been an indication for extraction, surgical crown lengthening, or post-and-core—a procedure that may compromise long-term prognosis by exposing the teeth to root fracture, periodontal intrusion, and absence of biomimicry.[14]

Endodontically treated teeth (ETT) with coronal loss present particular biomechanics challenges based on compromised remaining structure and altered stress distribution. Clinical trials and meta-analyses all confirm that adhesive partial restorations and minimally invasive pressed lithium disilicate onlays have the same or superior survival compared to full crowns, depending on the criteria of sufficient tooth structure and adhesion protocols. Indirect partial coverage, as opposed to full-crown coverage, preserves residual enamel, optimizes bond strength, and maintains biomechanical integrity of ETT.[15]

Sectional matrix systems like Palodent® V3, used for pre-endodontic build-up, represent a fundamental advance in margin elevation for deep or subgingival carious lesions and defective restorations. These systems facilitate the creation of anatomically precise, well-adapted resin walls, restoring suitable contours, and supporting successful endodontic isolation. The flexibility provided by nickel-titanium separator rings, adjustable wedges, and custom-designed matrix width can handle the large variation of morphologies ranging from wide missing or deep walls to re-establish proximal contacts and sound margins even in difficult defects.[9]

Pressable lithium disilicate possesses flexural strength of 370–460 MPa, while CAD/CAM varieties contain 360–400 MPa. Fracture toughness of lithium disilicate is 2.5–3.5 MPa·m^0.5, which is significantly higher compared with feldspathic or leucite-reinforced ceramics. The optical properties, including translucency and color, closely mimic natural enamel, supporting highly esthetic posterior restorations. Properly polished lithium disilicate shows wear profiles near that of enamel and is less abrasive than some ceramics, reducing antagonist wear. The excellent biocompatibility, high strength, and optical properties of LD support its integration in restorative protocols for ETT, where the remaining natural tooth structure may be compromised both functionally and esthetically.[16,17]

Preparation design for adhesive onlays in ETT must achieve a balance between mechanical reinforcement, adhesive potential, and conservation of tooth structure. Modern protocols favor non-retentive, defect-specific preparations with minimal occlusal and axial reduction, rounded internal angles, and supragingival, butt-joint margins, maximizing residual enamel for bonding and reducing stress concentrators that could induce failure. Cuspal coverage (at least 1.5–2.0 mm reduction on functional cusps) is recommended in cases of substantial coronal destruction, as often seen in ETT, to limit cuspal flexure and mitigate fracture risk. The preparation should preserve as much sound dentin and enamel as possible. Retentive or complex geometries should be avoided, as they increase internal stresses and risk of fracture or debonding. Studies using finite element analysis and in vitro fatigue testing consistently demonstrate that non-retentive, simplified preparations yield lower stress concentrations in the restoration and cement layer, while preserving tooth structure and enhancing long-term mechanical performance.[18,19]

High marginal adaptation and optimal internal fit of the onlay restoration are critical for minimizing secondary caries risk, marginal staining, and periodontal complications. Multiple studies report marginal discrepancy values in the 44–90 µm range for heat-pressed lithium disilicate, well within the clinically accepted standard of ≤120 µm. Pressed lithium disilicate onlays exhibit internal fit values on par with or better than alternative ceramics, especially when fabricated using digital impressions or precise analog techniques. Though CAD-CAM techniques may slightly outperform press techniques in some studies, the difference is typically minor and tends to be clinically negligible when strict laboratory controls are observed.[20,21]

Fracture remains the most reported reason for failure in ceramic partial-coverage restorations on ETT, given their altered biomechanical profile. However, lithium disilicate onlays demonstrate outstanding performance in this respect. Lithium disilicate onlays show fracture resistance values ranging from 900 N to over 1800 N in most contemporary in vitro studies—substantially above average masticatory forces (300–900 N in the posterior region). Overlay designs (full-cusp coverage) recorded significantly higher fracture strength and lower catastrophic failure rates compared to endocrown or partial coverage restorations, supporting their indication in ETT where structural integrity is compromised. Studies confirm that IDS and the use of a biomimetic composite substructure (biobase) or fiber-reinforced base do not compromise fracture resistance or marginal adaptation; rather, they may further enhance stress distribution and slow crack propagation. Thermomechanical aging (5000+ cycles, 5–55°C; 1.2 million loading cycles) does reduce ultimate fracture strength to a limited degree, but clinical thresholds remain amply exceeded for all but the thinnest and most extensive onlays. Experimental and clinical evidence indicate that lithium disilicate onlays, adhesively bonded with IDS and modern resin cements, reliably reinforce ETT and withstand physiological—and even parafunctional—loading.[18,22]

Lithium disilicate onlays and overlays yield 98–99% median survival at five years and 91–96% at ten years, outperforming composite and feldspathic ceramics, and closely rivaling gold or zirconia for partial-coverage indications. One- to three-year follow-ups in ETT restored with LD onlays report no catastrophic failures, minimal debonding or marginal discoloration, and high (Alpha) USPHS scores for function, biology, and esthetics. The most frequent cause of failure, often associated with inadequate thickness, faulty occlusal adjustment, or inappropriate preparation design. Less common, usually related to suboptimal adhesive protocols or moisture control; IDS and rigorous bonding steps greatly reduce risk. A small proportion of late failures are linked to marginal breakdown and subsequent secondary caries; careful preparation, IDS, and high-quality cements mitigate against this.[23–26]

Strengths of the presented approach include the use of evidence-based diagnostic frameworks (ICDAS, AAE pulpal/apical diagnoses), integration of modern sectional matrix systems allowing for conservative, reproducible build-up even in deep or subgingival lesions, and use of state-of-the-art endodontic and restorative technologies for optimal outcomes. Likely limitations exist fundamentally in catastrophic restoration failure or debonding risk when adhesive protocols are breached, occlusal loading is inadequately controlled, or in undermined periodontal condition. These risks are avoided through preservation of inherent tooth structure, rigorous isolation, and best-practice restoration protocol adherence. More extensive follow-up beyond more than three months would also improve durability in this and equivalent scenarios.

## CONCLUSION

The integration of pre-endodontic build-up with indirect adhesive restoration provides a conservative and predictable approach for managing posterior teeth with extensive root defects, enabling preservation of structural integrity and supporting long-term biologic and functional success. This case illustrates the potential of modern multidisciplinary dentistry—encompassing ICDAS-based diagnosis, pre-endodontic build-up with sectional matrix systems, biomechanical root canal therapy, single-cone obturation with bioceramic sealer, and adhesive cementation of lithium disilicate onlays—to achieve total tooth preservation in complex structural malformations of maxillary molars. When executed with meticulous preparation design, optimal surface treatments (etching and silanization), and judicious selection of high-performance resin cements, adhesive lithium disilicate onlays deliver durable, aesthetic outcomes for endodontically treated teeth.

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