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Ceramic Bonded Inlays-Onlays: Case Series

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Abstract:- Inlay/onlay restorations have emerged as a conservative and effective approach to restore posterior teeth with extensive cavities, while considering aesthetic, biological, and mechanical factors. This restorative technique has gained significant popularity in routine dental practice and has been extensively documented in scientific literature, owing to advancements in digital technologies and contemporary aesthetic materials. Nonetheless, the effectiveness and durability of inlay/onlay restorations hinge upon achieving optimal alignment between clinical indications, preparation principles, material selection, and bonding protocols. In this article, an updated perspective on this type of partial prosthesis is presented through two clinical cases report: the first case report which describes the rehabilitation of a severely damaged maxillary molar using an Indirect CAD/CAM fabricated ceramic inlay-onlay, thereby shedding light on the latest advancements in this field. The second case report that illustrates the restoration of two pulpless premolars previously filled with GIC (Glass Inomer cement) with two indirect CAD/CAM inlays and onlays using lithium disilicate-reinforced glass-ceramic materials

I. INTRODUCTION

In modern dental practice, the principles of tissue preservation and therapeutic gradient have become essential, driven by advancements in digital technology and the availability of contemporary aesthetic materials. The introduction of adhesive techniques has facilitated the adoption of a conservative approach that prioritizes the preservation of dental tissue, minimizing the need for extensive peripheral preparation when restoring teeth. The emergence of minimally invasive aesthetic dentistry has revolutionized the restoration of devitalized teeth. Even in the presence of moderate decay, it is now possible to select root-free prosthetic solutions for these teeth.

Bonded indirect restorations represent a significant advancement in restorative dentistry over the past few decades. They offer numerous advantages in terms of aesthetics, biology, and biomechanics when restoring the dental structure. Indirect bonded partial restorations (IBCRs) can be broadly categorized into two main types: anterior IBCRs, including veneers and chips, and posterior IBCRs, encompassing inlays, onlays, overlays, veenerlays, and table tops.

Among these options, bonded ceramic inlays-onlays stand out as a contemporary, highly aesthetic, and conservative therapeutic choice for restoring decayed teeth, whether vital or pulpless. However, their success and longevity rely on achieving a precise alignment between clinical indications, adherence to preparation principles, careful selection of materials, and appropriate bonding protocols.

➢ *Case Report 1*

A female patient, aged 40, with good overall health, presented at the Fixed Prosthodontics Department at the dental clinic in Monastir seeking dental consultation for the restoration of her endodontically treated first molar filled with a defective amalgam. The patient did not exhibit any parafunctional habits. Upon removal of the filling on the first molar, a moderate occluso-proximal cavity was observed, with the decay extending near the gingiva. Considering the extent of the decay and the patient's aesthetic expectations, a lithium disilicate-reinforced glass-ceramic inlay-onlay was fabricated using indirect CAD/CAM technology, in alignment with the principles of the therapeutic gradient.

Fig 1 Initial state

Pre-prosthetic treatment encompasses scaling and root planing procedures, as well as effective oral hygiene motivation techniques.

The preparation phase for prosthetic treatment involves the removal of irreversibly damaged tissue. A specific coronal layout is essential to optimize the placement and longevity of the prosthetic element. The following parameters should be taken into consideration:

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- The floor and axial walls should feature rounded angles.
- Internal walls should exhibit a divergence of at least 10°.
- Clear cavo-superficial limits should be established without the use of bevels.
- Occlusal impacts should not coincide with the tooth-restoration interface.
- The main isthmus should have a minimum width of 2mm.
- The mesiodistal width of the proximal box must be at least 1mm.
- Restorations should have a minimum thickness of 2mm at the occlusal groove.
- The cervical level should have residual walls with a minimum width of 2mm, while the occlusal level should have walls of at least 1mm in width.
- Restorative materials should have a thickness of 1.5 to 2mm at the level of covered cusps.
- It is recommended to establish a defined limit at the covered cusps, known as a congeal limit.

Fig 2 Proximale Inlay Preparation + Proximal Margin Relocation

Fig 3 One-Phase Impression

Fig 4 Lithium Disilicate-Reinforced Glass-Ceramic Inlay on Model

➢ *Try in and Bonding :*

To evaluate the aesthetic appearance of the inlay-onlay restoration, a fitting procedure was performed, following a specific bonding protocol. Initially, a watertight surgical drape was applied to isolate the tooth, ensuring a dry working area. The inner surface of the restoration, known as the denture intrados, was etched using 10% hydrofluoric acid for 30 seconds and subsequently treated with a silane coupling agent. Simultaneously, the tooth surface underwent etching with 37% orthophosphoric acid: 30 seconds on enamel and 20 seconds on dentin. An adhesive agent was then applied without light-curing to avoid excessive thickness. The inlay-onlay prosthesis was carefully placed, and a dual-setting luting resin, such as Variolink®, was injected. Each side of the restoration underwent 40 seconds of light-curing to ensure proper polymerization and bonding between the prosthesis and the tooth structure.

- *Treatment of Restoration Intrados*

Fig 5 Application of Hydrofluoric Acid: Chalky White Appearance

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Fig 6 Silane Application on the Inlay Intrados

- *Dental Surface Treatment*


Fig 7 Etching with 37% Orthosphoric Acid Followed by Rinsing and Drying

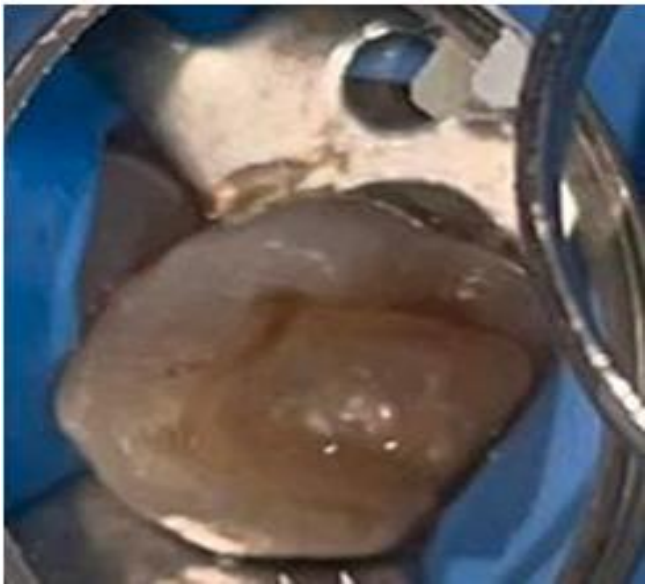
Fig 8 Adhesive Application

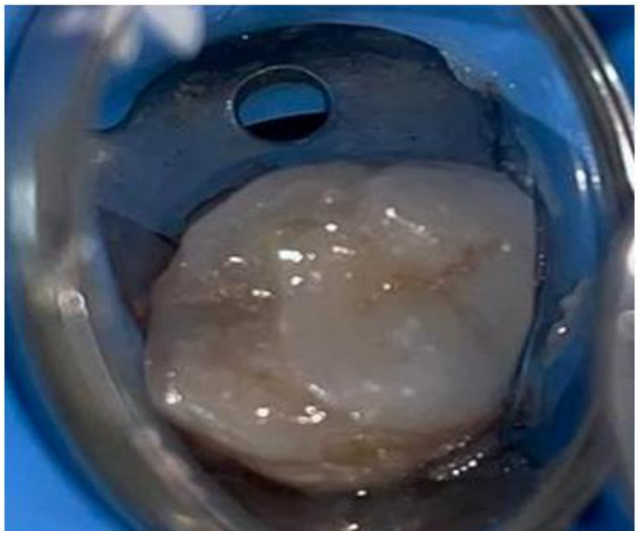
Fig 9 Bonding


Fig 10 Photopolymerization

➢ *Control :*

After one week's bonding, the dynamic occlusion was checked and polished.

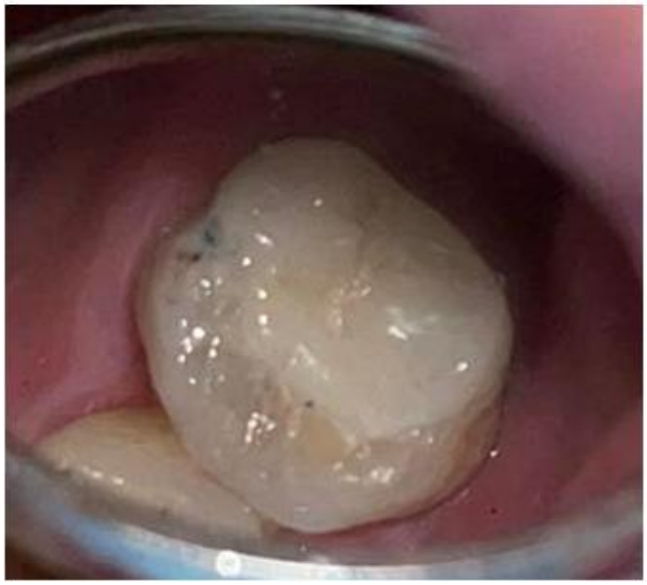
Fig 11 Final Result

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➢ *Case report 2:*

A healthy 28-year-old patient consulted the Fixed Prosthodontics Department at the dental clinic in Monastir to restore two pulpless premolars previously filled with GIC (Glass Inomer cement). She has high aesthetic expectations. Endobuccal examination revealed two proximal GIC fillings on teeth 24 and 25. Occlusion examination showed canine protection on both sides without any parafunctional habits. Smile analysis indicated a generally favorable situation, except for the mesial part of the teeth being uncovered. Upon removal of the existing fillings on the two premolars, moderate-sized occluso-proximal cavities were detected, with the decay extending near the gingival margin. Considering the extent of decay, the patient's requirements, and the therapeutic gradient, the treatment plan involved fabricating two indirect CAD/CAM inlays and onlays using lithium disilicate-reinforced glass-ceramic materials. In this case, it is crucial to perform a cervical margin relocation using composite resin to optimize bonding and facilitate the impression-taking process. This step will enhance the overall success of the restorations.

Fig 12 Initial state

Fig 13 Proximale Inlay Preparation + Proximal Margin Relocation

Fig 14 One-Phase Impression

Fig 15 Lithium Disilicate - Reinforced Glass - Ceramic Inlay on Model

Fig 16 Application of Hydrofluoric Acid: Chalky White Appearance

Fig 17 Silane Application on the Inlay Intrados

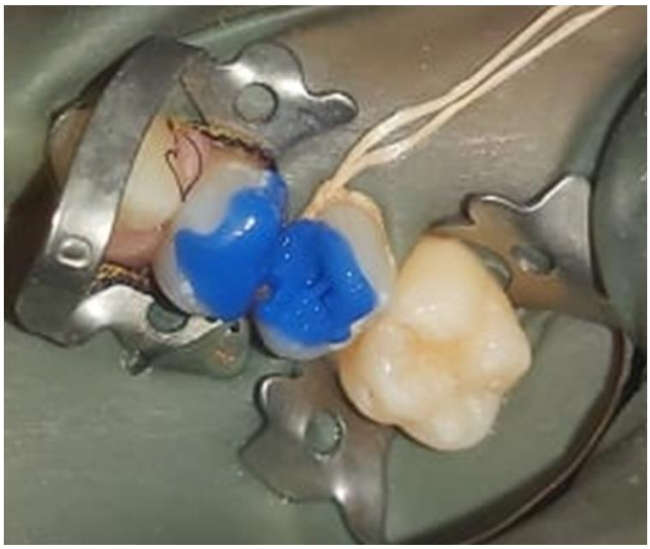
Fig 18 Etching with 37% Orthosphoric Acid


Fig 19 Adhesive Application


Fig 20 Bonding


Fig 21 Light-Curing


Fig 22 Final result

II. DISCUSSION

To restore endodontically treated teeth, practitioners commonly utilize peripheral restorations with or without posts. In modern dentistry, treatment decisions are guided by various principles, including the therapeutic gradient, biomimicry/biocompatibility, tissue preservation, and adhesion. The selection of the least invasive technique appropriate for the clinical situation is recommended, aligning with the principles of tissue sparing and the therapeutic gradient concept.

Multiple restorative options have been proposed for pulpless teeth, ranging from the least invasive to the most invasive approaches. These include direct composite resin restorations, bonded partial restorations (such as inlay-only, overlay, and endocrown), and full-coverage crowns.[1]

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Direct composite resin restorations are mainly indicated for teeth with minimal or moderate decay and no significant discoloration, within a favorable occlusal conditions. However, in the presence of a large cavity, the stresses experienced during polymerization shrinkage of composites using the direct technique are significant and can lead to recurrent caries, cracks, or fractures.[2,3]

In those two clinical cases, the loss of substance occurs at the expense of a proximal wall with a loss of more than one-third of the buccolingual width. In such cases, the direct technique cannot be performed primarily due to mechanical reasons. Therefore, an indirect bonded partial restoration is recommended, which represents an essential aspect of the modern therapeutic armamentarium in dentistry.[4]

Although limited studies have been conducted on the prognosis of indirect bonded partial restorations for pulpless teeth, a study by Chrepa et al. involving 31 premolars and 158 molars reported a survival rate of 96.8% at 37 months.[5]

Bonded inlay-onlays are considered reliable, conservative, modern, and aesthetically pleasing therapeutic solutions due to advancements in materials and digital dentistry. Studies have shown a high success rate (90% at 12 years) for bonded inlay-onlays, although failures, despite their relatively low in rate (1.9%), should not be overlooked. According to Otto's 2017 study, failures in these restorations can be attributed to ceramic fracture (65%), tooth fracture (13%), secondary caries (18%), and endodontic problems (4%).

This study found also that inlay-onlay restorations in premolars presented a significantly lower risk compared to molars.[6] This finding was consistent with another study that also observed a similar pattern.[7] However, the analyzed data did not provide conclusive evidence regarding the specific reasons behind this discrepancy. It remains unclear whether this difference is due to technical factors, such as variations in tooth anatomy or load-bearing capacity, or if it is influenced by better accessibility for treatment or the patients' oral hygiene practices.[6] Further research is warranted to explore these factors and establish a more definitive understanding of the observed variations in risk between premolars and molars in relation to inlay-onlay restorations.

To minimize these complications and failures, it is essential to carefully consider the indications for this type of restoration, choose the appropriate material, and adhere to the principles of preparation and bonding protocols.

Inlays and onlays are particularly useful in situations such as substantial loss of substance greater than one-third of the buccolingual width or loss of a cusp, as well as in Site 1-2, stage 3-4 (according to the SisTa classification), and for multiple restorations on the same arch to achieve precise occlusal and proximal contacts, restore the occlusal plane, maintain satisfactory periodontal and occlusal status, and accommodate pulp or pulpless teeth with juxta/supragingival cavities and good oral hygiene. However, several contraindications should be considered, including cases where more than half of the tooth structure is missing, presence of parafunctional habits, pronounced cuspal inclination, and anterior teeth.

The choice of restoration technique and material for endodontically treated teeth should be guided by the extent of tooth decay. While standardized preparations are no longer recommended, certain criteria must be respected. These include ensuring uniform depth and width of the preparation, with a minimum width of 1.5mm for composite restorations and 2mm for ceramic restorations. The cavity bottom should be flat, the walls should have a minimum divergence of 10°, and the preparation profile should have a wide fillet or shoulder with a rounded internal angle. The peripheral limit of the preparation should be supragingival, and the occlusal limit should be located outside the areas of occlusal impact, whether in the occlusal intercuspal position or dynamic occlusion.[8,9,10,11]

Cuspidial coverage may be indicated in certain situations, such as when the thickness of the amelo-dentinal wall is less than 1mm occlusally and 2mm cervically after caries removal, when the interocclusal maximum (IOM) occlusion touches the dento-prosthetic joint, when the tooth is pulpless and all cusps need to be covered, when a cusp supports a laterally positioned group protection guide, in the case of deep cavities that increase the risk of fractures, and when the height/width ratio of a cusp is greater than 1, increasing the risk of fractures below the amelo-cemental junction. However, cuspidial coverage should only be performed when the indication is well-established, as it may contradict the principle of tissue economy.[9,10] In certain situations, fragile residual walls can be preserved using a dentin substitute such as hybrid or fluid composite or bulk fill.

This technique, known as immediate dentin sealing (IDS), creating a hybrid layer between the adhesive and the demineralized dentin collagen surface after preparation and before taking the impression. The adhesive used typically involves a 3-stage pre-etch (MR) (MR3) system, as it provides better water resistance compared to self-etch systems. IDS offers biological and clinical advantages, such as eliminating the risk of bacterial contamination of dentin, improving adaptation of the prosthetic part, harmonizing the internal architecture of the preparation when performed with a fluid composite, and reducing post-operative sensitivity in cases of pulpless teeth.[12] Cervical margin elevation involves relocating the cervical margin to a supragingival level (generally around 1 to 1.5mm) by bonding a plastic phase material to the intrasulcular margin. This technique aims to preserve as much tooth tissue as possible and facilitate the registration of preparation contours. Recent studies have shown that this technique reduces ceramic fractures when the preparation margin is below the enamel-cement junction.[13,14]

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Dental restorations can be accomplished using various materials, including composites and ceramics. Composite resins are available in two forms: micro-filled and hybrid composites. Micro-filled composites pose a risk of fatigue overload and intra-material fractures, whereas hybrid composites offer superior mechanical resistance and enhanced aesthetic properties. Vitreous matrix ceramics are commonly employed due to their excellent bonding characteristics. Glass-ceramics enriched with leucite crystals or lithium disilicate crystals are suitable for all types of partial restorations and can be fabricated either by pressing from an ingot or through CAD/CAM techniques.[1,15,16] Lithium disilicate-enriched glass-ceramic inlays-onlays demonstrate outstanding performance and reliability, with estimated survival rates ranging between 92% and 95% at 5 years and 91% at 10 years. Nine machinable CAD/CAM blocks currently available in the market fall into the category of "hybrid" materials, including nanoceramic-filled resins and polymer-infiltrated ceramics.[17]

When selecting a material for dental restoration, several factors should be considered. The restoration of the antagonist tooth is crucial to consider, as it is preferable to choose the same material for both teeth to ensure similar wear. The substrate to which the material is bonded is also important, and a material with a modulus of elasticity close to that of dental tissue is preferred to ensure similar deformation during functional movements. Glass-ceramic restorations are preferable when bonding to enamel, while composite restorations are preferred when bonding to dentin. The presence of parafunctions, such as bruxism, is another factor to consider. In such cases, a composite restoration is preferable, as ceramic may break. Composite is also the material of choice for repairs, as it is easy to repair and readjust. Patient aesthetic requirements should also be considered, as ceramic has good optical properties and leads to satisfactory aesthetic results compared to composite. However, if the buccal margin is too visible, a composite restoration can be made in the mouth after bonding. Ceramic remains the most biocompatible material biologically, with regard to the tissue microenvironment.[16,18]

Table 1 Comparison of the Properties of Composites and Ceramics for Partial Single-Tooth Restorations

Parameters	Ceramics	composites
Ease of clinical procedures	+	++
Ease of Laboratory	+	+++
Intra-oral repairs and touch-ups Buccal	0	++
Aesthetics: - short-term - long-term	+++ +++	+++ ++
Polishing	+	++
Material wear resistance	+++	++
Fragility	+	++
Bonding efficiency	+++	+
Coefficient of thermal expansion	++	++
Chemical stability	+++	+
Biocompatibility	+++	++
Cost	0	+

III. CONCLUSION

Bonded partial restorations can be an alternative treatment option for moderately decayed teeth. The principle of tissue preservation should also apply to decayed teeth. Therefore, the use of a coronal-radicular anchor and peripheral crown should not be systematic, but reserved for situations of severe decay, very unfavorable occlusal contexts, and restorations where the quality of the substrate would not be compatible with quality.

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